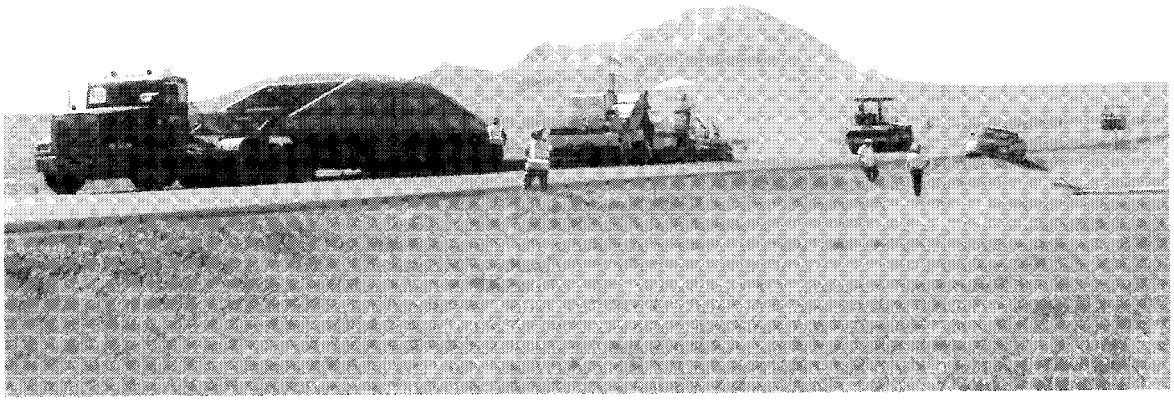
South Dakota

QC/QA

Asphalt Concrete Training Manual

January 2007



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January 2007

QC/QA ASPHALT CONCRETE TRAINING MANUAL

prepared by

South Dakota Department of Transportation
Division of Planning/Engineering
Materials and Surfacing Program

prepared for

Asphalt Concrete QC/QA Special Provision
Bituminous Certification Program

presented by

South Dakota Department of Transportation
Division of Planning/Engineering
Materials and Surfacing Program

This training manual is based upon the South Dakota Department of Transportation Special Provision Regarding Quality Control / Quality Assurance Specifications for Asphalt Concrete Pavement, SD DOT Standard Specifications for Roads and Bridges, SD DOT Materials Manual, SD DOT Policies and Procedures, SD DOT Certification Program Manual and AASHTO / ASTM Methods of Sampling and Testing as of the date this manual was printed.

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FORWARD

SDDOT, along with the Asphalt Industry, has always tried to maintain their level of expertise in an ever-changing environment. The Asphalt Industry, which includes Asphalt Cement Suppliers, Aggregate Producers, Asphalt Concrete Producers, Federal Highways Administration, and the SDDOT, has realized that a change in the way that we do business will improve the quality of our asphalt pavements.

In January of 1996, a meeting was held to bring the entire Asphalt community together to start a process of sharing information and training. This meeting, although not immediately realized, has led to a large effort in improving the quality of our asphalt pavements.

Since January of 1996, there have been numerous meetings, phone calls, and faxes working out the Quality Improvement Program that we all want. This Quality Improvement has led to the formation of a Specification Task Force for developing a QC/QA specification that not only deals with procedures for Quality Pavement but also has provided the necessary checks and balances we need. Unified goals are essential to implement a Quality Improvement Process.

The advent of QC/QA Specification Implementation requires an intensive training process. This process began with the Executive Hot Mix Asphalt Seminars held across SD in October 1996. This training continued with the first of many Bituminous Technician Training Classes that began in December of 1996 and will continue for many years in the future.

The QC/QA Asphalt Concrete Training Manual is current as of the printing date. It is anticipated that this manual will be a used as a training document and updated in the future as we see the need for changes.

It is the desire of the contributing authors of this manual that it will serve as a valuable reference for those involved with asphalt construction in South Dakota.

INTRODUCTION

For many years, Transportation engineers have been looking at asphalt pavements for solving the infrastructure pavement needs. These ever-growing needs caused by heavy truckloads and increased traffic volumes mandate that we build asphalt pavement right the first time. The SDDOT does not have the financial independence to fix or repair all our highways in the State Truck System to full design requirements when they need attention. SDDOT presently has a backlog of highway needs and prioritizes those highway segments according to need. To keep this backlog static, or at best reducing the total, the Asphalt Construction Industry is called upon to deliver pavements that meet or exceed their design life.

SDDOT has adopted Quality Control / Quality Assurance methods for monitoring the asphalt mix produced to give the citizens of South Dakota a long lasting high performance asphalt pavement. Across the nation, nearly every State is looking into Quality Improvements necessary to provide highways that meet the Traveling Public's Requirements.

With asphalt mix designs many variables exist. These variables include aggregate (crushed/rounded, gradation, particle shape, etc.) and asphalt binder (different sources). Many combinations of these variables exist within the boundaries of South Dakota. The proper asphalt content and air void levels are critical to the long-term performance of the asphalt pavement. In the Asphalt Concrete Mix Design Process, the proper configuration of all the ingredients is necessary for long-term pavement performance.

This Quality Control/Quality Assurance Asphalt Concrete Training Manual is provided to those in the industry as a ready reference. This training manual includes SDDOT's QC/QA Specification, Training Requirements, Asphalt Mix design Procedures, along with applicable policies relating to asphalt construction current at the time of printing.

Our intent is to provide personnel involved in the design and construction of asphalt pavements with the information needed to perform their tasks with Quality in mind.

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Section Number 1

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QC/QA ASPHALT CONCRETE TRAINING MANUAL

1. PURPOSE AND PROCESS:

The purpose of the South Dakota Quality Control / Quality Assurance Asphalt Concrete Training Manual is to explain the inspection, sampling, and testing methods necessary to comply with the Special Provision For Quality Control / Quality Assurance Specifications For Asphalt Concrete Pavement. This manual will serve as a guide for the Contractor, the Aggregate Producer, and SD DOT personnel.

Quality Control is the responsibility of the contractor.
Quality Assurance is the responsibility of the state.

The Contractor shall provide a Quality Control System that assures all asphalt concrete materials and constructed pavement, including aggregate process control and handling conforms to the contract requirements.

2. SCOPE FOR SPECIAL PROVISION:

This training manual is applicable to the production and construction of hot mix pavement on all projects let including the Special Provision for Quality Control / Quality Assurance Specifications For Asphalt Concrete Pavement. Use the Special Provision that is included in the plans as it may be an updated version of the Special Provision included in this training manual.

3. CERTIFICATION PROGRAM FOR TECHNICIANS ON QC/QA PROJECTS:

The purpose of this program is to develop and maintain a pool of well-trained technicians for the Department and its contractors, and to test and manage highway construction materials. The intent of this program is to improve the quality and performance of pavements through knowledge and understanding of the products.

The Contractor shall have a minimum of one Level II certified tester conducting the QC testing and one Level III certified person on the project. The State shall have a minimum of one Level II and one Level III certified tester on the Project. The certified technicians must be present at the plant and roadway whenever the plant is supplying asphalt concrete to the roadway.

The requirements for certification are shown in the Materials testing and inspection certification program manual in this section which is current as of the printing date.

4. SAMPLING AND TESTING MATERIALS:

Aggregate material shall be sampled from the cold feed belt in a manner that will assure a representative sample is obtained. The procedures in SD 201 and SD 213 shall be followed to obtain and reduce the material sampled to the testing size. Aggregate sample size shall be large enough to obtain four (4) splits of the minimum sample size needed (6 splits if an IA sample) for testing. The QC splits are to be retained until the QC, QA, and IA technicians have obtained their tests results for the individual lot and have found their results to be within the allowable tolerances in Table G of the Special Provision for QC/QA Specifications for Asphalt Concrete Pavement and Appendix G^4 of the AASHTO Implementation Manual for Quality Assurance shown in Section 10. The QA splits are to be retained until the end of the Project.

Hot mix asphalt samples shall be obtained from behind the paver screed or from the windrow in front of the pickup machine in a manner that will assure a representative sample is obtained. The procedures in SD 312 and SD 313 shall be followed to obtain and reduce the material sampled to the testing size. The sample shall be large enough to obtain 4 splits and make reheat samples if necessary (6 splits if IA is obtained). The QC splits are to be retained until the QC, QA, and IA technicians have obtained their tests results for the individual lot and have found their results to be within the allowable tolerances in Table G of the Special Provision for QC/QA Specifications for Asphalt Concrete Pavement and Appendix G^4 of the AASHTO Implementation Manual for Quality Assurance shown in Section 10 and the Project Engineer has told the QC technician. The QA splits are to be retained until the end of the Project and the Bituminous Engineer has completed the F and t tests on the sets of test results.

If the difference between the QC and QA/IA test results is greater than allowed in Table G or Appendix G^4, the Engineer will investigate the reason for the difference. This investigation will include review and observation of sampling, splitting, test equipment condition, and testing procedures on a sample. If upon test result review, equipment or procedural problems are found, the problems will be corrected and documented.

Asphalt binder and liquid asphalt are to be sampled according to SD 301. Asphalt binders require a sample of two 1 quart metal cans per 200 tons of material. The sample shall be obtained from an in-line sampling valve located between the storage unit and the mix plant. Emulsions require a sample of two 1/2 gallon plastic jugs per individual conveyance of asphalt. Other liquid asphalt requires a sample of two 1 quart metal cans per individual conveyance of asphalt. The oil content will be determined daily by using SD 314. Hydrated lime shall be sampled once per 750 tons according to SD 502 if not furnished from a certified lime plant.

These procedures shall be used by certified technicians on all projects let with the Special Provision For Quality Control/ Quality Assurance Specifications for Asphalt Concrete Pavement. Test data and forms shall be submitted on SD DOT forms unless the Engineer

approves other forms for use. The forms shall be submitted in a timely manner to the Area and Region personnel.

Test procedures in this manual are the current procedures at the time of printing of this Training Manual. The current edition of sampling and testing procedures used by the South Dakota Department of Transportation will be in the SDDOT Materials Manual and at the SDDOT website sddot.com

5. TEST REPORTS AND CONTROL CHARTS:

Test results shall be reported on South Dakota DOT forms unless approved by the Engineer. Numbering shall begin with a QC or QA or IA -1 and run consecutively throughout the Project. IA or QA tests shall be referenced to their corresponding QC or QA tests. Non payfactor material shall be labeled with an N before the test number. The core samples shall be numbered consecutively with an A and a B for each sublot. A computer program called Material Sampling and Testing (M S & T) in the Construction Management System will be used on Projects and the numbering system will be according to the requirements of the system. Computations and rounding numbers shall be as required by the Materials Manual and the new (M S & T) system.

Roadway diaries are to include; hours paved, equipment in use, stations paved, course, depth, width, crown, spread checks, tonnage, weather, and temperature of mix delivered to the road. Plant diaries are to include; plant start and shutdown times, mix temperature of material produced, oil spot checks, aggregate bin splits being used, actual calculated oil percentage for the day, tons plant produced, mix and binder content changes, and weather conditions. This list is not complete and may be expanded to cover as much pertinent data as you wish. There are no restrictions on such notes and eventually they may be valuable. The Project Engineer will be responsible for collecting the information from the inspectors and recording it in the project diary.

Control charts shall be maintained for gradation, binder content, air voids, and density for the Project. The QC technician shall maintain the control charts and the QA technician shall give test results to be added to the charts in a different pen color and also give the IA samples to be added as they become available in a different color as well.

The current forms are in the SD DOT Materials Manual. An electronic version is available in the M S & T system.

6. TEST FREQUENCY REDUCTION GUIDELINES:

The Area Engineer may reduce the frequency of tests needed for plasticity index, lightweight particles, and fractured faces. The reduction is based upon the test results obtained from the first lot of material tested and the results of tests obtained from each lot thereafter.

7. COMPARISON OF QUALITY CONTROL AND ACCEPTANCE TESTS OR INDEPENDENT ASSURANCE TESTS ON ENTIRE PROJECT:

The purpose of this procedure is to provide a method of comparing two different sets of multiple test results. This procedure can be used to compare the contractor QC tests to the DOT QA tests and the DOT IA test results to determine if the material tested came from the same population. The procedure for this is from the AASHTO Implementation Manual for Quality Assurance (February 1996) Appendix F. This is the F and t test statistical procedures which will be conducted by the Bituminous Engineer.

8. SDDOT PROFICIENCY SAMPLE PROGRAM:

Contractors or consultants doing mix designs for the South Dakota Department of Transportation must participate in South Dakota DOT's round robin Proficiency Sample Program.

9. QC/QA PROJECT INSPECTION REPORT:

This section is a checklist of items for QC/QA Projects. This list in not all inclusive and is not intended to include every necessary item.

Section Number 2

Section Number 2

Section Number 2

STATE OF SOUTH DAK0TA
DEPARTMENT OF TRANSPORTATION
SPECIAL PROVISION
FOR
QUALITY CONTROL/QUALITY ASSURANCE SPECIFICATIONS
FOR ASPHALT CONCRETE PAVEMENT

DECEMBER 11, 2006

Delete Section 320 from the Standard Specifications in its entirety and replace it with the following revised specification:

320.1 DESCRIPTION

These requirements are applicable to all Quality Control/Quality Assurance (QC/QA) hot mixed asphalt pavements irrespective of class, type, asphalt material, or pavement use. The work consists of constructing one or more courses of asphalt concrete mixture on a prepared foundation.

320.2 MATERIALS

A. Composition of Mixtures: The asphalt concrete shall be composed of a mixture of aggregate, asphalt, and approved modifiers. Unless otherwise specified in the plans, no reclaimed asphalt pavements (RAP) are allowed in QC/QA hot mixed asphalt pavements. Aggregate fractions shall be combined in proportions that result in the asphalt mixture meeting the specified requirements.

The operation of the plant shall not commence until the Bituminous Engineer has verified, in writing, a job mix formula meeting the specification requirements (Table A) for the asphalt concrete specified. The mixture shall conform within the range of tolerances established by the job mix formula target values shown in Table F.

B. Aggregates: Aggregates shall conform to the requirements specified in this provision.

C. Asphalt Binder: Asphalt binder shall conform to Section 890.

D. Hydrated Lime: Hydrated lime shall conform to Section 760.

E. Burner Fuel: Burner fuel used for production of asphalt concrete shall be propane, butane, natural gas, Grade 1 fuel oil, Grade 2 fuel oil, Grade 4 fuel oil, Grade 4 (light) fuel oil, Grade 5 (light or heavy) fuel oil, or Grade 6 fuel oil. Fuel oil heavier than Grade 2 shall meet the requirements of ASTM D396. Recycled fuel oils, RF04, RF05L, and RF05H may also be used provided they meet the requirements of ASTM D6448. The Contractor shall certify that each load of fuel meets the applicable ASTM specification. Recycled fuel oils and fuel oils heavier than Grade 2 shall be properly preheated and

efficiently burned. Production of mix shall be stopped if flameouts or signs of incomplete combustion occur.

320.3 CONSTRUCTION REQUIREMENTS

A. Weather and Seasonal Limitations: Asphalt concrete shall not be placed when the underlying surface is wet or frozen. Asphalt concrete shall not be placed when weather conditions prevent proper handling, compaction, or finishing. The temperature and seasonal limitations are as follows:

MINIMUM AIR TEMPERATURES & SEASONAL LIMITATIONS

Compacted Thickness	Surface Course		Subsurface Course & Shoulder Course	
	Min. Temp.	Seasonal Limits	Min. Temp.	Seasonal Limits
1" (25 mm) or less	45°F (7°C)	May 1 to Oct. 15 (inclusive)	45°F (7°C)	none
over 1" (25 mm)	40°F (4°C)	May 1 to Oct. 15 (inclusive)	40°F (4°C)	none

B. Equipment:

1. Requirements for All Plants: The central plant for mixing the mineral aggregate and asphalt may be a batch or drum mix type mixing plant.

Stockpiles of mineral aggregate shall be kept separate and adequate measures to prevent contamination must be used at stockpile sites. Segregated piles will be rejected until corrected.

When mineral filler, hydrated lime, or other additives are required, a separate feed system shall be provided to store and accurately and uniformly proportion the required quantity into the mix.

All cold feed bins shall be equipped with dividers to prevent overflow of aggregates into the adjacent bins.

The plant shall be equipped with emission control equipment including a dust collector capable of eliminating or conserving the dust necessary to meet gradation limits and environmental standards.

Recycled fuel oils and fuel oils heavier than Grade 2 used for burner fuel shall be properly preheated and efficiently burned. Production of mix shall be stopped if flameouts or signs of incomplete combustion occur.

A pyrometer or other thermometric instrument shall be installed in the supply line between the storage tank and the discharge point in the plant to accurately measure the temperature of the asphalt binder.

The plant shall be equipped with accurate weighing and volumetric measurement devices.

Asphalt binder storage tanks shall be kept level. Accurate calibration charts, which show the quantity of material contained in a tank at each 1/4 inch (5 mm) increment(s) of depth and a suitable device to measure the depth of the material, shall be provided. Storage tanks shall uniformly heat the material, under effective and positive control, to the required temperature. Heating shall be accomplished by steam coils, electricity, or burners, provided the flame does not come in direct contact with the heating tank. The asphalt circulating system shall be of adequate size to ensure proper circulation during the entire operating period. An accurate thermometer must be installed in the tank so temperature can be monitored.

Hydrated lime, when added, shall be added at the pugmill to moistened aggregate containing a minimum moisture content of 1.0 percent above the saturated surface dry condition of the aggregate, as noted on the approved mix design report. The mixing of the aggregate, hydrated lime and water shall be accomplished by using an enclosed twin-shaft pugmill with a minimum effective length of 4.5 ft (1.4 m). A water spray system must be installed at the discharge end of the pug mill. This water system must be used when directed by the Engineer to prevent fugitive lime dust from being released into the air.

When hydrated lime is used, the Contractors hydrated lime system shall be equipped with scales to accurately determine the amount of hydrated lime used at any time.

2. **Batch Type Mixing Plants:** Batch type plants shall have at least two storage bins with sufficient capacity to furnish the quantity of mineral aggregate materials necessary to operate at the calibrated capacity of the plant. Each compartment shall have partitions that prevent diversion of material into other compartments. Vibrators shall be provided to prevent bridging or arching of the bin contents.

   Batch plants shall be fully automatic, to the extent that the only manual operation required would be for the proportioning of one batch utilizing a single actuation switch or starter.

   The automatic unit shall include a timer to automatically control the measuring, mixing, and dumping processes through a central control. The automatic unit shall include a time lock device, which is capable of controlling the operations of a complete mixing cycle.

   A recording pyrometer shall be mounted in the discharge chute of the dryer. Daily charts of continuous aggregate temperature readings shall be submitted to the Engineer.

3. **Drum Mix Plants:** The dryer drum shall uniformly heat, coat, and mix the materials without overheating the materials and adversely affecting the mixture.

   a. Materials and additives shall be fed simultaneously into the dryer.

   b. The aggregate feed system shall provide positive control of the aggregate feed that can be easily and accurately calibrated. The rate of feed shall be continuously monitored, by belt scale, or other device that is interlocked with the asphalt metering mechanism.

   c. The asphalt metering device shall positively control the rate asphalt is introduced into the mixture and shall instantaneously adjust to variation in the aggregate feed rate.

   d. Production shall be limited to the rate required to obtain uniform aggregate coating and a uniform mixture meeting job mix temperature requirements. The rate must be within manufacturers rated plant capacity.

   e. A recording pyrometer shall be mounted in the discharge end of the mixer for determining the temperature of the mix. Daily mix temperature readings shall be submitted to the Engineer.

4. **Pavers:** Self-propelled pavers shall be equipped with a hopper having a bottom conveyor, a full width vibrating screed with heaters and be capable of spreading and finishing the mix to the specified widths, typical sections and thickness. The paver shall provide an accurate, smooth, uniform textured spread, and provide preliminary compaction.

   An attachment shall be provided on the paver that will place a beveled edge on the mat as specified.

   Pavers shall be equipped so that the height and transverse slope of the screed is automatically controlled using a fixed or traveling stringline on either or both sides of the paver. The traveling stringline shall utilize either mechanical skis or non-contacting grade averaging sensors. The traveling stringline shall have a minimum effective length of 28 feet (8.5 meters). The system shall be capable of manually controlling the transverse slope and the screed height.

5. **Rollers:** Rollers for compacting the asphalt concrete shall be of the self-propelled type, capable of producing a smooth surface finish. The number and weight of rollers furnished shall be sufficient to compact the mix to the required density. The rollers shall be capable of being reversed smoothly, without shoving or tearing the asphalt concrete

   Rollers shall be equipped to prevent "pickup" on the tires or drums. Moistening the drums or tires with water, a water detergent solution, or enclosing the roller to prevent

heat loss from the tires may be required. The use of fuel oil or other petroleum solvents to prevent "pickup" will not be permitted. Measures shall be taken to prevent oil, grease, or fuels from being dropped on the mat by rollers or any other type of equipment.

C. Laboratories:

1. **Quality Control Laboratory:** The Contractor shall furnish and maintain a Quality Control (QC) laboratory at the plant site. The laboratory shall be furnished with the necessary space, equipment, and supplies to properly perform all specified testing. The laboratory equipment shall meet the requirements of the test methods contained in the Department's Materials Manual and Materials Testing & Inspection Certification Program Manual. A copy of the equipment calibration records shall be kept in the QC laboratory.

   The Contractor's QC laboratory shall be equipped with a mechanical convection oven meeting the requirements of Section 600 of the Standard Specifications.

   The Contractor shall furnish a cut off saw equipped with a diamond tipped blade. The saw is to separate the core samples to the actual lift thickness. The cores shall be sawed to the correct lift line prior to testing the cores for density.

2. **Quality Assurance Laboratory:** The Contractor shall also provide a separate Quality Assurance (QA) laboratory for QA testing performed by the Engineer. The QA laboratory shall meet the requirements of Section 600 of the Standard Specifications.

D. Quality Control:

1. **Contractor Furnished Quality Control Program:** QC for the asphalt concrete pavement is the responsibility of the Contractor. The Contractor shall provide and maintain a QC program. The program shall assure that all asphalt concrete materials and constructed pavement submitted for acceptance conforms to the contract requirements. The Contractor shall be responsible for all asphalt concrete materials and constructed pavement, including aggregate process control and handling.

   The Contractor shall provide at least one certified level II technician for conducting the QC testing and one certified level III technician for roadway inspection. All of the Contractors QC technicians shall meet the Departments certification requirements or be under the direct supervision of a certified technician for the type of work they are actually performing. The certified technicians must be present at the plant and roadway whenever the plant is supplying asphalt concrete to the roadway.

At or prior to the preconstruction meeting the Contractor shall submit a QC plan to the Engineer for approval. The plan shall contain the following minimum requirements:

a. The names and phone numbers of the individual(s) responsible for the Contractor's QC program.

b. A listing of the certified technician(s) responsible for the QC inspection, material sampling, and testing.

c. A copy of the completed Performance Checklist, Training and Evaluation Records for all Temporary or Seasonal personnel who will be performing QC inspection or sampling and testing.

d. An organizational chart indicating lines of authority.

e. The Contractor shall notify the Engineer if a Control Test Strip will be used. The Contractor may produce approximately 500 tons (500 metric tons) of material to establish a roller pattern and verify the field produced mix properties match those of the lab mix design. After test strip placement further mixing and laydown operations will be suspended until the laboratory test results of the asphalt mixture and core densities are available. The material used in the test strip will be not be included in the mix payfactor analysis. The material used in the test strip shall be tested for all the properties listed in Table D. The Engineer shall approve the location of the test strip.

   If a Control Test Strip is not constructed, the QC plan shall specify how the contractor will establish a roller pattern to achieve the specified density and volumetrics.

The Engineer will provide the following to the Contractor at the preconstruction meeting:

The names of the certified individuals in charge of Quality Assurance (QA) testing and roadway inspection.

An organizational chart including the names and phone numbers of those in the direct line of authority.

2. **Mineral Aggregate Testing Prior to Production:** The aggregate producer shall provide test results to the Contractor and Engineer for each stockpile of mineral aggregate that will be incorporated into the asphalt concrete mixture. The aggregate producer shall use a certified Level II technician. The required tests shall include gradation, fractured faces, liquid limit, plasticity index (PI), and lightweight particles at the following minimum frequencies:

One test per 1500 tons (1500 metric tons) for each mineral aggregate ingredient produced.

A minimum of three tests for each mineral aggregate stockpile.

The Contractor may vary the frequency of the fractured faces, liquid limit, plasticity index (PI), and lightweight particles tests on ledge rock sources depending on the quality and uniformity of the materials.

3. **Contractor Furnished Mix Designs:** Asphalt concrete mix designs shall be performed by the Contractor and verified by the Department's Bituminous Mix Design Lab. A certified level IV technician shall perform the asphalt concrete mix design. All Contractors submitting mix designs to the SDDOT are required to participate in the Proficiency Sample Program. 50 percent of the plan quantity or 15,000 tons (15,000 metric tons), which ever is less, of the mineral aggregate shall be produced prior to submission for the mix design. Composite samples for aggregate quality testing shall be submitted to the Department's Bituminous Mix Design Lab a minimum of fifteen working days prior to hot mix production. Mix designs will only be performed on samples when accompanied by the following information:

   a. A completed data sheet (form DOT 1), including the legal description of mineral aggregate source(s).

   b. Representative mineral aggregate samples shall be proportionate to the bin splits proposed for use during construction. The total mineral aggregate submitted for mix design verification shall be from 150 to 300 pounds (70 to 140 kilograms).

      The samples shall be obtained by the Contractor and delivered to the Department's Bituminous Mix Design Lab in Pierre. The Contractor shall notify the Project Engineer prior to sampling and submitting the mix design aggregate.

   c. A summary sheet showing all test results from the gradations completed and the average gradation of each mineral aggregate stockpile produced along with the proposed bin split to be used in the asphalt concrete pavement.

   d. A one-gallon (four liter) sample of asphalt binder intended for use shall be obtained from the designated supplier for the project.

   e. A temperature viscosity chart or the kinematic viscosity at 300 and 150 centistokes. A recommendation from the asphalt binder supplier on the lab and field mixing and compaction temperatures shall be included for all asphalt binders.

   f. The specific gravity of the asphalt binder intended for use.

g. A mix design report and form DOT 48 that includes the lab data and results required in SD 316. The Contractor's mix design shall meet all of the mix design specifications.

When the mix design verification is completed by the Department's Bituminous Mix Design Lab, an approved mix design report will be provided to the Area Engineer and the Contractor prior to production. The mix design report will include the single percentage of aggregate passing each required sieve size, a single percentage of asphalt binder to be added to the aggregate, a single asphalt binder application temperature, a single temperature at which the mix is to be discharged from the mixer, and a single temperature at which the mix is to be delivered on the road.

4. **Mix Design Requirements and Specifications**: The mix design criteria shall conform to the requirements in Table A as designated in the plan notes (low, medium, or high volume traffic).

TABLE A - MIX DESIGN SPECIFICATIONS			
	Class Q		
	Low Volume Traffic (LVT)	Medium Volume Traffic (MVT)	High Volume Traffic (HVT)
MIX DESIGN PARAMETERS	**SPECIFICATIONS**		
% Air Voids	3.0 Min.	3.5 Min.	4.0 Min.
% VMA* 3/4" (19 mm) nominal maximum size	13.0 Min.	13.5 Min.	14.0 Min.
% VMA* 1/2" (12.5 mm) nominal maximum size	14.0 Min.	14.5 Min.	15.0 Min.
Marshall Blows	50	50	75
Marshall Stability	1000 Min.	1500 Min.	1800 Min.
Marshall Flow	8-18	8-16	8-16
Dust/Binder Ratio (based on effective binder)	NA	0.6-1.4	0.6-1.2
Moisture Sensitivity**	80 Min.	80 Min.	80 Min.
COMPOSITE MINERAL AGGREGATE REQUIREMENTS (without hydrated lime)			
Gradation	***	***	***
+#4 (4.75 mm) Frac. Faces % Min.	50% 1-FF	70% 2-FF	95% 2-FF
-#4 (4.75 mm) Manufactured Fines	N/A	20% Min.****	70% Min.****
+#4 (4.75 mm) Lt. Wt. Particles	4.5 % Max.	3.0 % Max.	1.0 % Max.
-#4 (4.75 mm) Lt. Wt. Particles	4.5 % Max.	3.0 % Max.	1.0 % Max.
Liquid Limit (LL)	25 Max.	25 Max	25 Max
Plasticity Index (PI)	3 Max.	N.P.	N.P.
L.A. Abrasion Loss	45 Max.	40 Max.	35 Max.
Sodium Soundness Loss (five cycles)			
+#4 (4.75 mm)	15% Max.	15% Max.	12% Max.
-#4 (4.75 mm)	15% Max.	15% Max.	12% Max.

* Evaluated for compliance during the mix design verification. If the percent passing the 1/2-inch (12.5 mm) sieve is greater than or equal to 90 percent the mix shall be considered 1/2-inch (12.5 mm) nominal maximum size. If the percent passing the 1/2-inch (12.5 mm) sieve is less than 90 percent the mix shall be considered 3/4-inch (19 mm) nominal maximum size.

** Moisture sensitivity will be tested according to SD 309. The moisture sensitivity requirement will be waived if 1.0% hydrated lime is added to the mix. Hydrated lime will not be required, or can be added at a rate lower than 1% if the moisture sensitivity requirements in Table A are met. If lime is used, a minimum of 0.5% hydrated lime shall be added to the mix. Liquid anti-stripping additives will not be allowed in lieu of hydrated lime.

*** The target values for the gradation shall be within the limits shown in Table B. After the target value is established, the tolerances in Table F will be applied.

**** Manufactured fines shall be manufactured solely from material retained on the 3/4 inch (19 mm) sieve, unless the aggregate material is produced from a ledge rock source.

TABLE B - TARGET VALUE RANGES

Sieve Size	Percent Passing
3/4" (19 mm)	100*
1/2" (12.5 mm)	75-95
# 4 (4.75 mm)	45-70
# 8 (2.36 mm)	30-55
# 16 (1.18 mm)	20-45
# 40 (425 μm)	10-30
#200 (75 μm)	3.0-7.0

* A tolerance of 3 percent may be retained on the 3/4" (19 mm) sieve provided all material passes the 1" (25 mm) sieve.

5. Quality Control Testing

a. Calibration Testing:

1) **Cold Feed:** Prior to production of asphalt concrete, the QC and QA certified technicians shall conduct comparison tests at the plant with a split companion cold feed calibration sample to assure that all associated equipment and procedures provide comparable results. Comparison test results shall conform to the tolerances shown in Table C. The split companion calibration testing shall continue until the results are within the listed tolerances.

2) **Mixture Testing:** The QC and the QA technicians shall perform correlation testing in the QC and QA field labs on a split companion sample supplied by the Contractor prior to beginning production of asphalt concrete. The sample may be plant-produced material used for spot leveling or non-mainline paving. The

correlation testing will be for bulk specific gravity (Marshall Method), maximum specific gravity (Rice Method), and an air void calculation. The results shall be within the tolerances shown in Table C.

3) **Bulk Specific Gravity Reheat Correlation:** The QC and the QA technicians shall perform a reheat correlation test for the bulk specific gravity. The reheat test shall be performed on a split of the first sublot of the mix design and again on the first sublot of any new mix design.

Cool a split portion of the sample down to room temperature. After the split sample has cooled, reheat and compact according to SD 313. Calculate the difference in the bulk specific gravities of the nonreheated and reheated tests. The average difference using the QC and QA technician's test results will be the correction factor for a reheated bulk specific gravity. This test may be repeated at the discretion of the Contractor or the Engineer.

TABLE C - SPLIT COMPANION TOLERANCES

Attribute	Tolerance
Sieve 3/8" (9.5 mm) & larger	± 5 %
Sieve #4 (4.75 mm) thru #50 (300 μm)	± 3 %
Sieve #100 (150μm) thru #200 (75 μm)	± 1.5 %
Lightweight Particles	± 1.0 %
Plasticity Index (PI)	± 1
Fractured Faces	± 10 %
Air Voids	± 1.2 %
Bulk Specific Gravity (Marshall)	± 0.020
Maximum Specific Gravity (Rice)	± 0.020

b. Asphalt Concrete Quality Control (Production) Testing: After the calibration cold feed and mixture testing is completed and the results are within the specified tolerances, the Contractor will be allowed to begin production of asphalt concrete.

The Engineer will randomly determine all sample locations at a frequency meeting the requirements of Table D. The cold feed gradation and the hot mix samples shall be obtained at the same random tonnage. The QC sample locations will be given to the contractor immediately prior to sampling. There will be a 200 ton (200 metric ton) buffer between the random sample locations. The intent of the buffer is to prevent back-to-back sampling and to more evenly distribute the sampling and testing workload.

A lot shall consist of five sublots. Sublots shall not represent more than 1000 tons (1000 metric tons) of asphalt concrete unless the current sublot is terminated.

The Contractor shall obtain QC samples at the specified locations for four of the five sublots. The Engineer will sample and split a minimum of one of the five

sublots, and witness all QC sampling. The Contractor shall test all five sublot samples (a split of the one sublot sampled by the Engineer and four sublot samples taken by the Contractor.) The material shall be sampled, split and tested by the methods and procedures described in the Department's Materials Manual.

The aggregate and hot mix samples shall be large enough to obtain four (4) splits of the minimum sample size needed for testing. If the sample is to be used for IA testing, the samples shall be large enough to obtain six (6) splits of the minimum size needed for testing. Immediately after splitting, the QA technician shall take possession of half of the sample for all of the QC samples. The QA technician shall ensure the Department's portion of the backup samples for all QC and QA tests are properly labeled, stored and retained until the end of the project. The QC technician shall retain their backup split until the QC, QA and IA technicians have obtained their test results for the individual lot and have found the results to be within the allowable tolerances in Table G, SD 317, and the Engineer has approved the disposal of the backup sample.

TABLE D - MINIMUM FREQUENCY FOR PRODUCTION SAMPLING/TESTING

TEST	MINIMUM FREQUENCY	TEST METHOD
Mineral Aggregate Gradation*	1/1000 ton (metric ton)	SD 202
Plasticity Index (PI)*	1/1000 ton (metric ton)	SD 207
Lightweight Particles*	1/1000 ton (metric ton)	SD 208 & SD 214
Fractured Faces*	1/1000 ton (metric ton)	SD 211
Max. Specific Gravity of Asphalt Concrete (Rice Method)**	1/1000 ton (metric ton)	SD 312
Bulk Specific Gravity of Asphalt Concrete** (Marshall Method)	1/1000 ton (metric ton)	SD 313
Asphalt Binder Content (sticking the tank)	1 per day	SD 314
Hydrated Lime Content	1 per day	
Moisture Content of Mix	1/10,000 ton (metric ton)	SD 305
Density, In Place***	2/1000 ton (metric ton)	SD 315

* Samples shall be taken according to SD 201 Section 3.2. The procedures in SD213 shall be followed to reduce the material sample to the testing size.

** Samples shall be taken from either the windrow in front of the laydown machine, or from behind the laydown machine. The Contractor shall have the option of where the samples are to be taken. The Contractor shall designate his choice of sampling locations at the preconstruction meeting.

*** Two density cores per 1000 ton (1000 metric ton) sublot shall be taken for determination of in place density. The average of the two core density results will be the 1000 ton (1000 metric ton) sublot value used for density in the pay factor calculations. The Engineer will determine and mark the core locations after the mix is placed and compacted. The cores will be taken the next working day after the asphalt pavement is placed. The Contractor shall perform the coring under observation by the Engineer. The Engineer will take immediate possession of the core samples for density testing. The Contractor shall fill all core holes before the end of the next working day with hot asphalt concrete and compact the mix to a density close to that of the surrounding pavement.

The Contractor may request to reduce the QC testing frequency when the QC and QA samples indicate acceptable results, within the specifications in Table A and the tolerances from Table G, for plasticity index (PI), lightweight particle, and/or fractured face tests, and the Engineer and the Contractor are both confident that future production will meet specifications. The reduction in test frequency will be authorized in writing by the Area Engineer.

The frequency of the QC testing for plasticity index, lightweight particles, and fractured faces may be further reduced by the Area Engineer. The Area Engineer may reduce the frequency beyond what is shown in the QC Test Frequency Reduction Guidelines based on an evaluation of test results from the material source. The Area Engineer shall notify the Contractor in writing of the reduction in testing frequency and a copy of this letter shall be forwarded to the Region Materials Engineer. A reduction in testing frequency may be revoked by the Area Engineer at any time.

The frequency of tests performed may be reduced using the following procedure. The QC technician will complete all tests on the first lot of material produced. A reduction in the frequency of testing will be allowed based upon the average test results obtained from the first lot of material tested by the QC technician. This reduction in test frequency for any of the tests shown in the QC Test Frequency Reduction Guidelines will remain in effect as long as the test results remain within the range of the testing frequency currently being used.

The QA technician will complete all of the required tests on the samples that are selected for QA testing.

QC TEST FREQUENCY REDUCTION GUIDELINES

Plasticity Index

NP to 0.5	Reduce test frequency to 1 test per lot
0.6 to 1.5	Reduce test frequency to 2 tests per lot
1.6 to 2.5	Reduce test frequency to 3 tests per lot
2.6 or greater	No reduction in test frequency

+ #4 & - #4 Lightweight Particles (less than 1.95 Specific Gravity)

0 to 0.9 %	Reduce test frequency to 1 test per lot
1.0 to 1.9 %	Reduce test frequency to 2 tests per lot
2.0 to 2.9 %	Reduce test frequency to 3 tests per lot
3.0 % or greater	No reduction in test frequency

Fractured Faces

25 % or more above minimum or results of 100 % Fr. Faces	Reduce test frequency to 1 per lot
16 to 24 % above minimum	Reduce test frequency to 2 tests per lot
6 to 15 % above minimum	Reduce test frequency to 3 tests per lot
Within 5 % of minimum	No reduction in test frequency

c. **Specification Control Limits:** The control limits of materials being produced will be evaluated under two different categories, Pay Factor Attributes and Nonpay Factor Attributes

1) **Pay Factor Attributes:** Air voids and in place density (compaction) are the two pay factor attributes. These attributes will be statistically analyzed for contract unit price adjustment.

The upper and lower specification limits for the pay factor attributes are determined by applying the following tolerances to the job mix formula target values:

TABLE E - PAY FACTOR ATTRIBUTES

Attribute	Tolerance
% Air Voids	± 1.0%
In Place Density (% Compaction)	Minimum Specified & Maximum Specified

The lower specification limit (LSL) for in place density is 92.0 percent of the lot average maximum specific gravity (Rice Method) test results for projects

designated as High Volume Traffic. The (LSL) for in place density is 91.0 percent of the lot average maximum specific gravity (Rice Method) test results for projects designated as Low and Medium Volume Traffic. The upper specification limit (USL) for in place density is 96.0 percent for all projects.

When field test results for air voids and/or in place density deviate from the job mix formula values, the Contractor may adjust the gradation and/or asphalt binder content within the allowable tolerances shown for items a, b, c, and d shown in Table F. Bin splits may be adjusted up to $\pm$ 5 percent from the job mix formula bin splits. Adjustments shall be made as a result of an interactive process between the Contractor and the Engineer. The Contractor's adjustment recommendations shall prevail, provided all specifications and established mix design criteria are being met.

Should job mix formula adjustments outside the tolerances become necessary or if new materials are required to be incorporated into the asphalt concrete, the contractor shall furnish a new mix design (unless otherwise approved by the Bituminous Engineer) with verification by the Department's Bituminous Mix Design Lab. The Contractor shall be responsible to verify that all mix design criteria are being met prior to written job mix formula approval.

When a new job mix formula is required, the current sublot shall be terminated and incorporated into the previous sublot for pay factor analysis. A new lot will be started when production is changed to the new job mix formula. At the end of production, the current sublot shall be terminated and incorporated into the previous sublot.

2) **Nonpay Factor Attributes:** There are several requirements that are not statistically evaluated for pay factor contract unit price adjustment that are very important to the performance of the asphalt concrete. These requirements are:

Mineral Aggregate Gradation
Lightweight Particles, percent <1.95 specific gravity
Liquid Limit (LL)
Plasticity Index (PI)
Fractured Faces, percent
Moisture Content of Mix

The above listed properties are not statistically evaluated for price adjustment, but will be tested for specification compliance. The properties shall be maintained within the tolerances from the job mix formula shown in Table F.

The Asphalt Binder and Hydrated Lime content are not statistically evaluated as pay factor attributes, but may be price adjusted (DOT-18) for failure to conform to specification requirements. The properties shall be maintained within the tolerances from the job mix formula shown in Table F.

TABLE F - JOB MIX FORMULA TOLERANCES

Attribute	Tolerance from Target Value
a. Sieve 5/8" (16 mm) thru 3/8" (9.5 mm)	± 7 %
b. Sieve #4 (4.75 mm) thru #50 (300 μm)	± 5 %
c. Sieve #100 (150 μm) thru #200 (75 μm)	± 2.0 %
d. Percent Asphalt Binder	± 0.3 %
e. Liquid Limit*	Maximum or less
f. Percent Lightweight Particles*	Maximum or less
g. Plasticity Index*	Maximum or less
h. Percent Fractured Faces*	Minimum or more
i. Percent Hydrated Lime	± 0.10 %
j. Asphalt Application Temperature	± 20°F (±11°C)
k. Temp. of Mixture when emptied from the mixer	± 20° F(±11°C)
l. Temp. of Mixture on delivery to the road	–20°F & +30°F (-11°C & +17°C)

*These properties are not listed on the job mix formula but will be tested for compliance with the mix design specifications listed in Table A.

If two out of any five consecutive tests for the gradation requirements (Items a, b, or c) fail to meet the tolerances contained in Table F, the Contractor shall immediately cease operations. The Contractor shall investigate the cause of the variation in production. Production will not be allowed to resume until a passing cold feed sample is obtained and the Engineer has approved the corrective action.

If the asphalt binder content or hydrated lime content falls outside the tolerance in Table F, the Contractor shall stop production until corrective measures are taken.

If the Liquid Limit, Lightweight Particles, Plasticity Index, or percent Fractured Faces (Items e, f, g, or h) for a single test fall outside the tolerances shown in Table F, the Contractor shall immediately cease operations. The Contractor shall investigate the cause of the variation in production. The Contractor will not be allowed to continue operations until a passing cold feed sample is obtained and the Engineer has approved the corrective action.

The maximum moisture content in the field-produced mix shall be 0.3 %. If the moisture content in the mix exceeds the maximum allowed the Contractor will be required to take corrective action that is documented by the Engineer. Burner adjustments, increase mix temperature, slower plant production rates, use of

drier aggregates, or adjust the amount of time material is in drum for mixing and heating are possible corrective actions. Additional moisture content in the field-produced mix tests shall be conducted to verify that the corrective action has worked to produce specification mix.

3) **Test Identification:** Number the production control sublot tests consecutively in accordance with the Department's Materials Manual starting with number "QC01" or "QC001" based on the total number of samples needed. The two density cores in a sublot shall have the same number along with an "A" or "B" designation and shall match the sublot number. Use "N" before the sublot number for non-payfactor material. Use "Info" before the number for information samples. Use "R" after the number for remedial samples. Use "Cal" before the number for calibration samples.

4) **Control Charts:** The Contractor shall provide QC charts that include the control limits and each individual test result for the following parameters:

   a. Gradation of the control sieves in the Job Mix Formula
   b. Asphalt Binder Content
   c. Hydrated Lime Content
   d. Maximum Specific Gravity (Rice)
   e. Bulk Specific Gravity (Marshall)
   f. Air voids
   g. In-place density.

   QC test results shall be recorded on the control charts immediately after completion of the test. The control charts shall also include the QA and Independent Assurance test results. The control charts shall be prominently displayed and accessible to the Engineer. The control charts shall be given to the Engineer upon completion of the project.

5) **Documentation:** The Contractor is responsible for documenting all observations, inspection records, mixture adjustments, and test results on a daily basis. The Contractor shall also record and maintain a plant record of plant starts and stops, mix temperatures leaving the plant, bin split of aggregates, and the temperature of the asphalt binder going into the mix.

   Field observations and inspections shall be noted as they occur in a permanent duplicating field book or diary, provided by the Engineer. The roadway diaries shall include: hours paved, equipment in use, stations paved, course depth, width, crown, spread checks, tonnage, weather, and temperature of mixture delivered to the road. Plant diaries are to include: plant start and shutdown times, mix temperature of material produced, binder spot checks, aggregate bin splits being used, actual calculated asphalt binder percentage for the day, tons of mix produced, mixture or aggregate adjustments, and weather conditions.

The Engineer will collect copies of documentation records and recorded mix temperature charts daily. All records shall be made available at all times upon request by the Engineer. The test results and original work sheets for the production control testing listed in Table D shall be given to the Engineer upon completion of the test.

E. Quality Assurance: The Engineer will randomly sample and test a minimum of one sublot for each lot. The Engineer may test any or all of the splits of the QC sublot samples as part of the QA program.

The services of contractor's personnel to assist in obtaining the QA samples should be limited only to instances when hazardous conditions or liability issues exists that dictate their involvement and the following requirements are met:

1. The QA sample location or time is only given to the contractor immediately prior to sampling.
2. The contractor's personnel are used only to provide labor to assist in physically obtaining the QA sample.
3. The Engineer is present to witness the taking of the QA sample.
4. The Engineer witnessing the sampling and the contractor labor performing the sampling are certified in accordance with the Department's Certification program.
5. The Engineer immediately takes possession of the QA sample.

QA test results will be made available to the Contractor within 24 hours, or the next working day.

The split sample test results (QA) of the sample taken by the Engineer will be compared to the Contractor test results (QC) for conformance with Table G. Populations of the QC sample test results will be compared to the QA sample test results utilizing the procedures shown in SD 317. If the test results are within the allowable tolerances and found to be similar the Contract unit price adjustments will be based on the Contractor QC test results.

Sampling and splitting not required to be performed by the Engineer will be witnessed by the Engineer.

The Engineer will test the core samples for density.

The Engineer will perform or witness the measurement of the depth of the asphalt binder in the storage tanks as described in SD 314. The Engineer will determine the temperature of the asphalt binder in the tank and will perform the daily calculation of the asphalt binder content.

The Engineer will perform the daily calculation of the hydrated lime content.

The Engineer will test the moisture content of the hot mix. The mix for the moisture test shall be sampled from the windrow in front of the laydown machine and placed in an airtight, tared container. The mix shall be dried to a constant mass as described in SD 305.

TABLE G - TOLERANCE BETWEEN QC, QA, AND IA TEST RESULTS

Attribute	Tolerance
Air Voids	± 1.2 %
Sieve 3/8" (9.5 mm) & larger	± 5 %
Sieve #4 (4.75 mm) thru #50 (300 μm)	± 3 %
Sieve #100 (150μm) thru #200 (75 μm)	± 1.5 %
% Lightweight Particles	± 1.0 %
Plasticity Index	± 1
% Fractured Faces	± 10 %
Bulk Specific Gravity (Marshall)	± 0.020
Maximum Specific Gravity (Rice)	± 0.020

F. Independent Assurance Procedures: The Department will perform Independent Assurance (IA) testing on project-produced materials. Random samples of mineral aggregate and hot mix asphalt concrete used for QC testing will be selected by the Region Materials Engineer for independent testing. IA testing will be performed at a minimum frequency of one per 10,000 tons (10,000 metric ton).

The Region Materials Engineer will perform IA testing for the attributes listed in Table G. The tolerances from Table G will be used to independently evaluate the QC and QA testing procedures and equipment. The Region Materials Engineer shall witness the sampling and splitting of the designated IA sample (an actual sublot sample). The Region Materials Engineer may select either Engineer or Contractor sampled sublot for the independent assurance testing.

The Region Materials Engineer will also perform IA testing for the bulk specific gravity on in place density cores. A separate IA core shall be obtained by the contractor while obtaining the in place density core used to determine the pay factor. The IA core shall be taken at the same offset and within one foot of the core used in determining the pay factor. An IA core must be taken during the first 5,000 tons (5,000 metric tons) of hot mix tested for in place density and then at a minimum frequency of one core per 10,000 tons (10,000 metric tons) thereafter. A tolerance of 0.020 will be used to evaluate the bulk specific gravity of the in place density cores.

G. Dispute Resolution System: If the difference between the QC and QA results is greater than allowed in Table G or SD 317, the Engineer will investigate the reason for the difference. The investigation may include review and observation of test procedures and equipment. The QA technician shall test the next QC sample as soon as a difference between any QC and QA test result is found. The Engineer may require that a sample be

tested jointly by the Contractor's QC technician, the Engineer's QA technician, and the Region Materials Engineer. Region Materials Engineer test results and/or Central Office Materials Lab test results will be the referee used for acceptance and will determine which sample test results will be incorporated into the pay factor calculations only when a dispute between the QA and QC sample cannot be resolved. Process verification procedures using F-test and t-test statistical evaluation procedures to determine if both QC and QA test results represent the same sample population may result in the need for testing backup sublot samples and substituting the new test results for pay factor calculations.

H. Preparation of the Mixture: The mineral aggregate shall be satisfactorily mixed with the proper quantity of asphalt binder at the central mixing plant. The asphalt binder shall be added and the mix produced at the temperatures established by the job mix formula.

The mixing plant shall be operated using automatic controls. Manual operation will be permitted for the remainder of the day when automatic controls fail, provided specified results are obtained. The Contractor shall restore the automatic operation prior to the next day's resumption of paving operations

In batch plants, the mineral aggregate shall be mixed dry for a minimum of five seconds.

After introducing the required aggregate and asphalt into the mixer the materials shall be continuously mixed until the aggregate is completely and uniformly coated and a thorough distribution of the asphalt binder throughout the aggregate is obtained.

When hot mix storage bins are used, storage of the asphalt mix shall be limited to a maximum of 15 hours. The point of temperature measurement will be the discharge end of the mixer.

I. Transportation and Delivery of the Mixture: The mixture shall be transported from the plant to the point of use in pneumatic tired vehicles. The vehicle boxes shall be tight, clean, and smooth. Boxes shall be cleaned only with release agents such as lime water, soap, a detergent solution, or a commercial product specifically intended for this use. Oils, diesel fuel, or other petroleum solvents shall not be used. No material shall be used which could adversely affect the asphalt concrete mixture. Excess solution in the box shall be disposed of before the vehicle is loaded.

Loads shall be tarped in inclement weather conditions and when directed by the Engineer.

J. Tacking, Spreading, and Compacting: The surface, including all vertical contact faces on which the asphalt concrete is to be placed, shall be tacked according to Section 330. The tack coat shall be allowed a cure period, as determined by the Engineer, prior to asphalt concrete placement.

Asphalt concrete shall be placed by self-propelled pavers. Handwork is permissible in inaccessible or odd shaped areas.

Spot leveling and repair of the existing surface with asphalt concrete shall be required prior to the paver laid courses at locations designated. Potholes and areas of localized disintegration shall be cleaned of loose material, squared, tacked, leveled with asphalt concrete, and satisfactorily compacted. Spot leveling may be blade laid in lifts not exceeding three inches (75 mm) of uncompacted depth. Compaction shall be by the specified roller coverage method, except a steel face roller will not be required.

Paver laid mix shall be spread using automatic transverse and longitudinal grade controls. If the automatic controls fail or malfunction, the Engineer may permit manual operation the remainder of the day, provided the finished product meets the specifications. Frequent breakdowns will be cause for suspension of the work by the Engineer until repair or replacement is made.

Following placement of the first pass using the traveling stringline for control, adjacent passes and succeeding lifts shall be placed using the traveling stringline riding on the previously laid material. A shoe attachment may be used to match the longitudinal joint(s) on the final paver pass(es) of the top lift unless otherwise directed by the Engineer.

A shoe attachment on the paver shall be used to automatically match the elevation of asphalt concrete shoulders with concrete pavements.

Automatic slope controls will be required on paving equipment used to pave asphalt shoulders that are 8 feet (2.4 m) or more in finished width.

Asphalt concrete shall be placed directly in a uniform windrow and then fed into the paver by a paver feeder. The use of a paver feeder is not required on shoulders, turning lanes less than 500 ft (150 m), roadway paving less than 500 ft (150 m), and transitions into bridge decks less than 500 ft (150 m). The paver feeder shall pick up substantially all of the mix and feed it into the paver without segregation. The size of the windrow shall be regulated so that the paver is fed a continuous and adequate supply of mix. The screed shall not be raised solely to accommodate excess material in the windrow or paver hopper. A Material Transfer Vehicle (MTV), which takes material directly from the trucks, stores and mixes it, and then dumps into the paver hopper may be used if approved by the Engineer.

On the final surfacing lift laydown operations shall commence at the farthest point and progress continuously toward the plant.

On rural projects, a partial width pass may be extended beyond the adjacent pass by as much as one days run. The paver shall be moved back the following working day to place the adjoining pass. Where a difference in elevation exists between two lanes

carrying traffic in the same direction on rural multi-lane asphalt concrete construction, one of the effected lanes shall remain closed to traffic.

The plant production and availability of hauling vehicles shall be sufficient to provide a uniform and consistent quantity of asphalt concrete to the paver so laydown operations are continuous. Stops and starts shall be restricted to a minimum. Stopping normal laydown operations to surface an approach, thereby creating an unnecessary joint, will not be permitted.

Laydown operations shall proceed from the center to the shoulders of the roadbed surface. When turning lanes are present, the Contractor may alter the laydown operation. The Contractor shall submit his proposed laydown operation to the Engineer for prior approval. The center joint of the top lift shall be located on centerline. Longitudinal joints below the surface shall be offset from the previously constructed joints by approximately 6 in. (150 mm) and be located within 12 in. (300 mm) of the lane line. In curb and gutter sections, laydown may proceed from the gutter line to the centerline.

Transverse joints in the final lift shall be formed by sawing back the previous run to expose the full depth of the course. The finished transverse joint of all lifts shall have a uniform texture and comply with the straightedge requirement. Waste material resulting from forming joints and temporary ramps shall be removed and disposed of by the Contractor.

Segregation or excessive pulling of the mix shall warrant suspension of operations.

Immediately after the mix has been placed and surface irregularities adjusted, it shall be thoroughly and uniformly compacted by rolling.

Vibratory rollers shall have an automatic shutoff to deactivate the vibrators when the roller speed is less than 0.5 mph. They shall operate according the manufacturer's recommendations for speed, impacts per foot, and amplitude of vibration for the thickness of mix being compacted. Rolling shall be longitudinal, commencing at the outer edges of the mat and progressing toward the center in straight, parallel strips, overlapping at least six inches (150 mm). On superelevated curves, rolling shall progress from the lower to the upper edge of the mat. The Contractor shall vary the points of reversal to prevent a transverse crease. The rollers shall not stand idle on any part of the mat that has not been compacted and cooled sufficiently to resist deformation.

The shoulders shall be compacted using the same roller pattern used on the adjacent mainline asphalt concrete or as directed by the Engineer. The beveled edge shall be satisfactorily compacted.

Longitudinal joints shall be compacted in accordance with the following:

For confined edges, on the first pass adjacent to the confined edge; the compaction equipment shall be entirely on the hot mat 6 in. (150 mm) from the longitudinal joint.

For unconfined edges, on the first pass adjacent to the unconfined edge, the compaction equipment shall extend 6 in. (150 mm) beyond the edge of the mat.

The surface of each lift shall be free of waves and other irregularities. The final lift surface shall be checked with a ten foot (three meter) straightedge. The variation of the surface from the straightedge between any two contact points shall not exceed 1/4 inch (3 mm). The crown, on all lifts, as indicated by checking with a ten foot (three meter) straightedge, shall be within 0.04 foot (12 mm) of specified crown in any ten foot (three meter) length.

Irregularities shall be corrected before the temperature of the asphalt mix drops below 175° F (80° C). The longitudinal profile can only be improved by using a grinder with diamond blades mounted on a horizontal shaft and when approved by the Engineer. Areas that have been ground shall not be left smooth or polished, but shall have a uniform texture equal in roughness to the surrounding unground asphalt concrete. Grinding shall be daylighted to the outside edge of the pavement. Ground surfaces shall be flushed sealed. Under no circumstances shall operations continue when it becomes evident final rolling is not producing a smooth, uniform, compacted surface free from roller marks and other irregularities.

The mix shall be compacted by one of the following methods: Unless otherwise specified, the specified density method shall be used.

1. **Specified Density Method:** The mix shall be compacted to the density specified. Compaction rolling shall be completed before the temperature of the mix drops below 175°F (80°C). Vibratory rollers may only be used in the static mode for finish rolling.

   Compaction of mix placed on farm entrances, residences, businesses, and intersecting road approaches shall be compacted by the specified roller coverage method.

2. **Specified Roller Coverage:** The mix shall be compacted by at least four complete coverage's with pneumatic tired rollers (a minimum of 60 inches wide [1500 mm] and weighing at least 250 pounds per inch [4.5 kilograms per millimeter] of roller width) and at least one complete coverage with steel faced rollers, or as approved by the Engineer. The steel faced rollers used for specified roller coverage shall be the same as the rollers used for mainline compaction or similar rollers of equal size (weighing at least 325 pounds per linear inch [5.8 kilograms per millimeter] of roller width).

   Breakdown rolling may be accomplished by using steel-faced rollers, only when approved by the Engineer.

Rolling shall proceed on the mat as soon as lay down is completed. Completion of rolling on any segment shall not lag behind the laydown more than 1000 feet (300 meters). During periods of cool weather this maximum distance between laydown and final rolling shall be reduced as directed by the Engineer.

Compaction to a specified density will not be required. However, additional roller coverage may be required to obtain a smooth surface finish.

When directed by the Engineer, the Contractor shall cool, saw, and remove an undamaged, 6 inch (150 mm) sample or a 6 inch (150 mm) diameter round sample from a designated area and repair the hole to the satisfaction of the Engineer. The Engineer shall take immediate possession of all samples for further testing.

320.4 METHOD OF ACCEPTANCE AND MEASUREMENT

A. Asphalt Binder: Asphalt binder will be measured to the nearest 0.1 ton (0.1 metric ton). Quantities of asphalt binder in excess of the asphalt content listed on the job mix formula plus 0.3% tolerance will not be accepted for payment.

B. Asphalt Concrete: Asphalt concrete shall be statistically accepted by lots. A lot shall consist of five sublots. Sublots shall not represent more than 1000 tons (1000 metric tons) unless the current sublot is terminated. The first lot shall start at the beginning of production.

A lot will be terminated when a new job mix formula is issued. If less than five sublots have been completed when a lot is terminated, the sublots will be included in the previous lot and the pay factor computed for the revised lot. If there is no previous lot, the lot will not be terminated until five sublots are obtained.

1. Determination of Contract Unit Price Adjustment: Asphalt concrete that is not compacted according to the Specified Density Method will not be included in the pay factor calculations. The material specified to be sampled and tested on a QC/QA basis will be evaluated for payment under this subsection. All QC test results for a lot will be analyzed collectively and statistically by the Quality Level Analysis-Standard Deviation Method using the procedures herein defined. The lots will be analyzed to determine the total estimated percent of the lot that is within the specification limits.

Quality Level Analysis (specification conformance analysis) is a statistical procedure for estimating the percent of material that is within the specification limits (PWL). The PWL is determined by using the lot mean, ($\overline{X}$ 1) and the lot standard deviation (s). Two measures of quality are required to establish the contract unit price adjustment. The first measure is the Acceptable Quality Level (AQL) which is the PWL at which the lot will receive 100 percent pay or a composite pay factor of 1.00. The second measure of quality is the Rejectable Quality Level (RQL) at which the Engineer has determined the material may not perform as desired and may be rejected.

The AQL has been selected at 90 PWL and the RQL at 60 PWL. The RQL using the pay factor equation will result in 85 percent pay or a pay factor of 0.85.

An individual pay factor for any attribute resulting in less than 85 percent pay may result in the lot being rejected.

When the Acceptable Quality Level of any individual pay factor attribute has a QL of 90 or less the composite pay factor shall not exceed 1.00.

A lot may be accepted provided the composite pay factor is at least 0.85 and there are no isolated defects identified by the Engineer.

A lot containing material with less than a 0.85 composite pay factor may be rejected. All of the rejected material shall be removed from the work. The Engineer will determine if the material may remain in place at a reduced price.

The Engineer may reject any quantity of material that appears to be defective based on visual inspection or test results. Causes for rejection may include but are not limited to segregation, low temperature material, and very high or low asphalt binder content. Such rejected material shall not be used in the work or included with the lot acceptance tests. Rejected material will not be measured for payment.

The Contractor may elect to remove any defective material and replace it with new material to avoid a pay factor less than 1.00. Any such new material will be sampled, tested, and evaluated for acceptance according to this specification.

2. **Quality Level Analysis:** The standard deviation method procedures are as follows:

   a. Only test results on material incorporated in the work will be included in the quality level analysis.
   b. Calculate the arithmetic mean ($\overline{X}$) of the test values:

$$\overline{X} = \frac{\Sigma x}{n}$$

Where: Σ = summation of
x = individual test value to x_n
n = total number of test values

c. Calculate the sample standard deviation (s):

$$s = \sqrt{\frac{n\Sigma(x^2) - (\Sigma x)^2}{n(n-1)}}$$

Where: $\Sigma(x^2)$ = summation of the squares of individual test values.

$(\Sigma x)^2$ = summation of the individual test values squared.

d. Calculate the upper quality index (Q_U):

$$Q_U = \frac{USL - \overline{X}}{s}$$

Where: USL = upper specification limit or target value (TV) plus allowable deviation.

Target Value = the single specification value which would result in an ideal product.

e. Calculate the lower quality index (Q_L):

$$Q_L = \frac{\overline{X} - LSL}{s}$$

Where: LSL = lower specification limit or target value minus allowable deviation.

f. Determine P_U (percent within the upper specification limit that corresponds to a given Q_U) from Table I.

Note: If a USL is not specified, P_U will be 100.

g. Determine P_L (percent within the lower specification limit that corresponds to a given Q_L) from Table I.

Note: If an LSL is not specified, P_L will be 100.

h. Determine the Quality Level (the total percent within specification limits).

$$\text{Quality Level (QL)} = (P_U + P_L) - 100$$

i. To determine the pay factor for each individual attribute (PF)= 55 + 0.5(QL).

j. Determine the Composite Pay Factor (CPF) for each lot. The third decimal place of the CPF shall be rounded to the nearest hundredth by the computer program.

$$CPF = \frac{[f_1(PF_1)+f_2(PF_2)]}{(100)\Sigma f}$$

Where: f = 1 to 2

$f_{1 \text{ or } 2}$ = price adjustment factor listed in Table H for each measured attribute.

$PF_{1 \text{ or } 2}$ = Pay Factor for each measured attribute.

Σf = Sum of the "f" (price adjustment) factors.

The asphalt concrete pavement contract unit price will be adjusted according to Section 320.4 of this specification. Payment for the asphalt concrete will be made at a price determined by multiplying the contract unit price by the composite pay factor. The following table will be used to calculate the composite pay factor:

TABLE H - PAY ATTRIBUTES & PRICE ADJUSTMENT FACTORS

Measured Attribute	Factor "f"
Air Voids	50
In Place Density (% Compaction)	50

Asphalt concrete will be measured to the nearest 0.1 ton (0.1 metric ton). The mixture of mineral aggregate and asphalt will be weighed after mixing. No deduction will be made for the weight of the asphalt included in the mixture.

Deduction will not be made for material removed from temporary approaches. Deductions will be made for all rejected asphalt concrete pavement.

C. Hydrated Lime: Hydrated lime, when provided to meet the moisture sensitivity requirements will be measured to the nearest 0.1 ton (0.1 metric ton). Quantities of

hydrated lime in excess of the lime content listed on the job mix formula plus 0.1% tolerance will not be accepted for payment.

D. QA and QC Field Laboratories: There will be no measurement or payment for the QC laboratory furnished and used by the Contractor to perform the QC testing. The Contractor furnished QA laboratory will be measured on a per each basis.

320.5 BASIS OF PAYMENT

A. Asphalt Binder: The accepted quantities of asphalt binder will be paid for at the contract unit price per ton (metric ton). The amount bid for this item shall be at least the cost of the asphalt binder furnished and delivered to the project site.

Payment for the asphalt binder is not subject to the statistical pay factor adjustment. The asphalt concrete is subject to removal or price adjustment.

B. Asphalt Concrete: The accepted quantities of asphalt concrete, will be paid for at the contract unit price as adjusted by the pay factor calculations in Section 320.4 of this specification per ton (metric ton) complete and accepted in place. The contract unit price of asphalt concrete shall include all cost for labor, equipment, materials, and all incidentals required to construct the control test strip, complete all mineral aggregate testing prior to production, complete QC testing, furnish and place the asphalt concrete mix according to these specifications.

C. Hydrated Lime: Hydrated lime will be paid at the contract unit price per ton (metric ton) complete in place. Payment for hydrated lime will only be made when hydrated lime is actually used. The amount bid for this item shall be at least the cost of the hydrated lime furnished and delivered to the project site.

D. Laboratories:

1. **QC Laboratory:** The laboratory used by the Contractor for QC testing shall be incidental to the asphalt concrete pavement item(s).

2. **QA Laboratory:** Payment for the QA laboratory will be according to Section 600 of the Standard Specifications.

Refer to Table I for the upper quality and lower quality index data for use in the pay factor calculations.

TABLE I - QUALITY LEVELS
QUALITY LEVEL ANALYSIS BY STANDARD DEVIATION METHOD

P_u or P_l Percent Within Limits for Positive Values Of Q_u or Q_l	UPPER QUALITY INDEX Q_U OR LOWER QUALITY INDEX Q_L															
	n=3	n=4	n=5	n=6	n=7	n=8	n=9	n=10 to n=11	n=12 to n=14	n=15 to n=18	n=19 to n=25	n=26 to n=37	n=38 to n=69	n=70 to n=200	n=201 to n=∞
100	1.16	1.50	1.79	2.03	2.23	2.39	2.53	2.65	2.83	3.03	3.20	3.38	3.54	3.70	3.83
99		1.47	1.67	1.80	1.89	1.95	2.00	2.04	2.09	2.14	2.18	2.22	2.26	2.29	2.31
98	1.15	1.44	1.60	1.70	1.76	1.81	1.84	1.86	1.91	1.93	1.96	1.99	2.01	2.03	2.05
97		1.41	1.54	1.62	1.67	1.70	1.72	1.74	1.77	1.79	1.81	1.83	1.85	1.86	1.87
96	1.14	1.38	1.49	1.55	1.59	1.61	1.63	1.65	1.67	1.68	1.70	1.71	1.73	1.74	1.75
95		1.35	1.44	1.49	1.52	1.54	1.55	1.56	1.58	1.59	1.61	1.62	1.63	1.63	1.64
94	1.13	1.32	1.39	1.43	1.46	1.47	1.48	1.49	1.50	1.51	1.52	1.53	1.54	1.55	1.55
93		1.29	1.35	1.38	1.40	1.41	1.42	1.43	1.44	1.44	1.45	1.46	1.46	1.47	1.47
92	1.12	1.26	1.31	1.33	1.35	1.36	1.36	1.37	1.37	1.38	1.39	1.39	1.40	1.40	1.40
91	1.11	1.23	1.27	1.29	1.30	1.30	1.31	1.31	1.32	1.32	1.33	1.33	1.33	1.34	1.34
90	1.10	1.20	1.23	1.24	1.25	1.25	1.26	1.26	1.26	1.27	1.27	1.27	1.28	1.28	1.28
89	1.09	1.17	1.19	1.20	1.20	1.21	1.21	1.21	1.21	1.22	1.22	1.22	1.22	1.22	1.23
88	1.07	1.14	1.15	1.16	1.16	1.16	1.16	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17
87	1.06	1.11	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.13	1.13
86	1.04	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08
85	1.03	1.05	1.05	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04	1.04
84	1.01	1.02	1.01	1.01	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.99	0.99
83	1.00	0.99	0.98	0.97	0.97	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.95	0.95	0.95
82	0.97	0.96	0.95	0.94	0.93	0.93	0.93	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
81	0.96	0.93	0.91	0.90	0.90	0.89	0.89	0.89	0.89	0.88	0.88	0.88	0.88	0.88	0.88
80	0.93	0.90	0.88	0.87	0.86	0.86	0.86	0.85	0.85	0.85	0.85	0.84	0.84	0.84	0.84
79	0.91	0.87	0.85	0.84	0.83	0.82	0.82	0.82	0.82	0.81	0.81	0.81	0.81	0.81	0.81
78	0.89	0.84	0.82	0.80	0.80	0.79	0.79	0.79	0.78	0.78	0.78	0.78	0.77	0.77	0.77
77	0.87	0.81	0.78	0.77	0.76	0.76	0.76	0.75	0.75	0.75	0.75	0.74	0.74	0.74	0.74
76	0.84	0.78	0.75	0.74	0.73	0.73	0.72	0.72	0.72	0.71	0.71	0.71	0.71	0.71	0.71
75	0.82	0.75	0.72	0.71	0.70	0.70	0.69	0.69	0.69	0.68	0.68	0.68	0.68	0.68	0.67
74	0.79	0.72	0.69	0.68	0.67	0.66	0.66	0.66	0.66	0.65	0.65	0.65	0.65	0.64	0.64
73	0.76	0.69	0.66	0.65	0.64	0.63	0.63	0.63	0.62	0.62	0.62	0.62	0.62	0.61	0.61
72	0.74	0.66	0.63	0.62	0.61	0.60	0.60	0.60	0.59	0.59	0.59	0.59	0.59	0.58	0.58
71	0.71	0.63	0.60	0.59	0.58	0.57	0.57	0.57	0.57	0.56	0.56	0.56	0.56	0.55	0.55
70	0.68	0.60	0.57	0.56	0.55	0.55	0.54	0.54	0.54	0.53	0.53	0.53	0.53	0.53	0.52
69	0.65	0.57	0.54	0.53	0.52	0.52	0.51	0.51	0.51	0.50	0.50	0.50	0.50	0.50	0.50
68	0.62	0.54	0.51	0.50	0.49	0.49	0.48	0.48	0.48	0.48	0.47	0.47	0.47	0.47	0.47
67	0.59	0.51	0.47	0.47	0.46	0.46	0.46	0.45	0.45	0.45	0.45	0.44	0.44	0.44	0.44
66	0.56	0.48	0.45	0.44	0.44	0.43	0.43	0.43	0.42	0.42	0.42	0.42	0.41	0.41	0.41
65	0.52	0.45	0.43	0.41	0.41	0.40	0.40	0.40	0.40	0.39	0.39	0.39	0.39	0.39	0.39
64	0.49	0.42	0.40	0.39	0.38	0.38	0.37	0.37	0.37	0.37	0.36	0.36	0.36	0.36	0.36
63	0.46	0.39	0.37	0.36	0.35	0.35	0.35	0.34	0.34	0.34	0.34	0.34	0.33	0.33	0.33
62	0.43	0.36	0.34	0.33	0.32	0.32	0.32	0.32	0.31	0.31	0.31	0.31	0.31	0.31	0.31
61	0.39	0.33	0.31	0.30	0.30	0.29	0.29	0.29	0.29	0.29	0.28	0.28	0.28	0.28	0.28
60	0.36	0.30	0.28	0.27	0.27	0.27	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.25	0.25
59	0.32	0.27	0.25	0.25	0.24	0.24	0.24	0.24	0.23	0.23	0.23	0.23	0.23	0.23	0.23
58	0.29	0.24	0.23	0.22	0.21	0.21	0.21	0.21	0.21	0.21	0.20	0.20	0.20	0.20	0.20
57	0.25	0.21	0.20	0.19	0.19	0.19	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
56	0.22	0.18	0.17	0.16	0.16	0.16	0.16	0.16	0.16	0.15	0.15	0.15	0.15	0.15	0.15
55	0.18	0.15	0.14	0.14	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
54	0.14	0.12	0.11	0.11	0.11	0.11	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
53	0.11	0.09	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
52	0.07	0.06	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
51	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02
50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

NOTE: For negative values of Q_U or Q_L, P_U or P_L is equal to 100 minus the table P_U or P_L. If the value of Q_U or Q_L does not correspond exactly to a figure in the table, use the next higher value.

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Section Number 3

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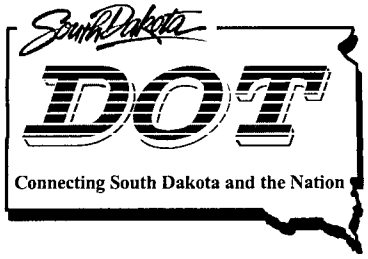
SOUTH DAKOTA
DEPARTMENT OF TRANSPORTATION



MATERIALS TESTING & INSPECTION CERTIFICATION PROGRAM MANUAL

Revised April 2006

SOUTH DAKOTA DEPARTMENT OF TRANSPORTATION

MATERIAL TESTING & INSPECTION CERTIFICATION PROGRAM MANUAL

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LIST OF ABBREVIATIONS

AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
AMRL	AASHTO Materials Reference Laboratory
ASTM	American Society for Testing and Materials
CCRL	Cement and Concrete Reference Laboratory
CFR	Code of Federal Regulations
FHWA	Federal Highway Administration
IA	Independent Assurance
NHS	National Highway System
NIST	National Institute of Standards and Technology
QC	Quality Control
QA	Quality Assurance
QC/QA	Quality Control and Quality Assurance
SDDOT	South Dakota Department of Transportation
SDBOP	South Dakota Bureau of Personnel

REFERENCES

SDDOT Standard Specifications for Roads and Bridges, current edition

SDDOT Materials Manual, current edition

GLOSSARY OF TERMS

AASHTO Accredited Laboratories - Laboratories that satisfy the quality system requirements specified in AASHTO Practice R 18 and received an on site assessment from AMRL and/or CCRL for which test method accreditation is being sought.

Abuse - An intentional deviation from approved procedures.

Acceptance Testing - Testing that is done for the acceptance of a product. These tests are generally run to find if the product falls within a minimum or maximum specified range.

Certified Individual - An individual, who has successfully demonstrated through passing the required written and/or performance exams, with the knowledge and skills required to properly sample and test material or provide inspection of construction activities.

Certification Program - The process in-place that provides the requirements for those seeking certification and administration of the program.

Course Exam - An exam taken at the end of an approved training course to gain Certification.

Direct Supervision:

a.) Materials Testing - A non-certified individual may perform tests or portions of tests only under direct observation of a Certified Technician until such time the non-certified technician demonstrates they can consistently perform the test or portion thereof in accordance with the outlined procedures. From that point on, the non-certified individual can perform the test or portion thereof whether or not a Certified Technician is physically present at the test site. The Certified Technician is however required to spend time at the project/laboratory on a daily basis. The Certified Technician assumes all responsibility for the accuracy of the test data and signifies so by placing their initials on the worksheet as the checker. For asphalt QC/QA & Superpave projects, the Contractor & DOT each shall have a minimum of one Level II certified tester conducting the QC testing on the project whenever the plant is supplying asphalt concrete to the roadway.

b.) Inspection - A non-certified individual may perform inspection of a phase of work only under the direct observation of a Certified Technician until such time the non-certified individual demonstrates a thorough understanding and knowledge of the requirements and procedures for that phase of work. From that point on, the non-certified individual may inspect that phase of work whether or not a Certified Technician is physically present on the project. The Certified Technician shall however spend time on the project on a daily basis. The Certified Technician assumes all responsibility for the accuracy of the documentation provided and shall place his/her initials on the document to verify review and approval. For asphalt QC/QA & Superpave projects, the Contractor & DOT each shall have a minimum of one Level III certified person on the project whenever asphalt pavement is being placed.

Dispute Resolution - When an action is questioned, another independent non-biased authority is brought in to determine a resolution to the dispute. This may involve, but is not limited to, re-testing of a sample or an in-place product.

Ethical Work - All work shall be accomplished honestly in a professional manner in accordance with the plans, specifications, contract, materials manual, or any other pertinent requirements. It shall be considered unprofessional and inconsistent with proper conduct and contrary to the public interest:

a) To act for his/her client or for his/her employer other than as a faithful agent or trustee.
b) To accept remuneration for services rendered other than from his/her client or his/her employer.
c) To attempt to injure (falsely or maliciously) the professional reputation of another individual or business.
d) To exert undue influence or to offer, solicit, or accept compensation for the purpose of affecting negotiations of a contract or contract item.
e) To act in any manner derogatory to honor, integrity, and dignity.

Independent Assurance (IA) Testing - Is an unbiased and independent evaluation of all of the sampling and testing procedures used in the acceptance program. The results of the IA tests are used to ensure that correct sampling and testing procedures are being used and that the testing equipment is properly calibrated. The IA tests results shall not be used as a basis of material acceptance.

Inspection - The process of observing, measuring, examining, testing, gauging, or otherwise evaluating materials, products, services, testing activities, and equipment to determine their acceptability in meeting specification requirements.

Misconduct - An intentional wrongdoing or deliberate violation of the requirements of the certification program.

Negligence - A repeated unintentional deviation from approved procedures, which may or may not cause erroneous results.

Permanent Employee - A full time individual employed by a company or organization, who normally works 40 hours per week 52 weeks per year for the same company or organization.

Performance Exam - An exam taken by an individual to show that he/she has the knowledge and ability to perform the specified test.

Proficiency Sample - A standardized sample given to multiple laboratories to evaluate the performance of the laboratories and those performing the tests.

Provisional Examination - An examination opportunity made available upon approval by the Certification Advisory Committee for QC/QA Asphalt Projects or by the Oversight Committee for the Materials Testing & Inspection Program to provisionally certify an individual so they may provide inspection or testing for the duration of a specific project which will be completed within one construction season. This process is permitted only when there is a shortage of certified individuals as a result of a locally heavy workload in combination with unforeseen circumstances. This individual must pass the written examination for the area of work in which they are going to perform. Following successful completion of the written examination, the provisional status individual must work under direct supervision of a certified individual for a

period of not less than 2 days to ascertain the individual knows the applicable project requirements and/or testing procedures.

Quality - Consistently conforming to mutually agreed upon requirements.

Quality Assurance - All those planned and systematic activities necessary to provide adequate confidence that a product or service will satisfy given requirements for quality. In the laboratory, quality assurance should provide adequate confidence in each test result reported by the laboratory.

Quality Control - The sum of total activities performed by the seller (producer, manufacturer, and/or contractor) to make sure that a product meets contract specification requirements. Within the context of highway construction this includes materials handling and construction procedures, calibration and maintenance of equipment, production process control, and any sampling, testing, and inspection that is done for these purposes.

Recertification Exam - An exam taken by an individual to obtain certification in those areas for another specified timeframe.

Reciprocity - When the Certification is granted to an individual based on other training, licenses, etc.

Re-test Exam - A different exam, other than the one that was previously failed, given to an individual to obtain certification.

Test Out - The ability of an experienced individual to successfully pass a recertification exam.

SOUTH DAKOTA DEPARTMENT OF TRANSPORTATION

MATERIALS TESTING & INSPECTION CERTIFICATION PROGRAM MANUAL

I. Objective:

The Federal Highway Administration (per 23 CFR 637 Subpart B) requires that all individuals performing acceptance testing or independent assurance testing shall be certified and all testing equipment be calibrated at a specified frequency for all work on the National Highway System. The intent is to continually improve the quality of our highway system. With the adoption of quality control/quality assurance specifications, many more individuals are testing and inspection, which requires training and good testing equipment to provide consistency and repeatability of results. The intent of the program is to assure that the quality of the inspection, testing, and testing equipment is uniform and consistent in providing quality results.

This program will benefit everyone. As individuals participate in the certification program, their knowledge and abilities will improve and become more uniform. They will gain more confidence in their work and have a better understanding of the important role they play in quality control. The individuals will learn more about the products they produce and importance of following the correct construction practices, material sampling, and testing procedures. With an improved work performance of those involved in construction projects, the performance standards in the construction industry will improve and the traveling public will also benefit from higher quality, longer lasting roadways.

All activities must be conducted in accordance with this manual.

A. There are three major parts to the program:

1. Calibration of Testing Equipment.
2. Material Testing Certification.
3. Inspection Certification of Individuals.

B. The Program applies to highway construction on all highway systems plus all informal/maintenance projects which require inspection as determined by the Region Engineer or Region Materials Engineer.

C. Any individual, who is performing acceptance or independent assurance testing of material, shall be certified.

D. Any individual, who is performing acceptance inspection of contract work in the areas designated by this program, shall be certified.

E. Overall Program Responsibility: The SDDOT Materials & Surfacing Program has the overall responsibility to administer this program. The duties and responsibilities of those individuals in the Materials & Surfacing Program to meet the administrative requirements shall be as outlined in this document.

F. Materials Manual: The current edition of the SDDOT Materials Manual, Standard Specifications or Special Provisions for QC/QA & Superpave Specifications for Asphalt Concrete Pavement shall be used as the source for the following:

1. Minimum Acceptance, Quality Control and Quality Assurance Testing Frequencies.
2. Minimum Independent Assurance Testing Frequencies.
3. Sampling and Testing Procedures.
4. Procedures for handling failing test results.
5. Procedures for the identification, conditioning, storage, retention, and disposal of test samples.

II. Testing Equipment: All testing equipment shall be calibrated to assure uniformity in the testing equipment and to provide more uniform test results. The Independent Assurance testing will be used to monitor uniformity of the testing equipment and procedures. Each entity is responsible for the maintenance and repairs of their own testing equipment.

A. Requirements: All testing equipment identified by the Materials & Surfacing Program shall:

1. Be calibrated at the required Frequency (Appendix 1).
2. Be calibrated according to the Equipment Calibration Procedures (Appendix 2), (Example Figure 1).
3. The equipment calibration shall be recorded on the Equipment Calibration Records (Appendix 2), (Example Figure 2). Where large numbers of a particular type of equipment exist, it will be permissible to list as many items on one record document as it will accommodate provided all required documentation, measurements, and any other required information is shown for each equipment item.
4. Equipment Calibration Records shall be retained for a period of 3 years.
5. No equipment shall be used for testing if it does not meet the calibration requirements. This may require corrective work or disposing of the non-conforming equipment.

B. Responsibilities:

1. Materials & Surfacing Program:
   a) Develop and furnish Equipment Calibration Frequencies, Procedures, & Records.

2. Region Materials:
   a) Calibrate SDDOT Region & Area equipment.
   b) Maintain equipment inventory.
   c) Maintain equipment calibration records.

3. Area Office:

a) Insure Area, Contractor, Consultant, or other's equipment is calibrated prior to use. This will require submitting Area Office equipment to Region Materials for calibration.

b) Review Contractor, Consultant, or other entities' records. The Area Office will need to insure that the consultant, contractor, or other entity's equipment calibration records are available for review on the project site. The Area Office is not required to check the equipment calibration, unless there appears to be a need. IA testing will be used to monitor accuracy of equipment calibration and uniformity of testing procedures. The Area has the authority to check equipment at any time for any reason.

4. Contractor, Consultant, or other entities:
   a) Calibrate their equipment prior to use on project.
   b) Maintain their equipment inventory.
   c) Maintain their equipment calibration records.
   d) Have a copy of current equipment calibration records available on project site.
   e) Cooperate in the inspection conducted by SDDOT of their facilities, equipment, and/or records.

5. Individual:
   a) Each individual shall be responsible for keeping well-maintained and clean equipment and workspace.
   b) Each individual shall assure that their equipment has been calibrated and is functioning as intended.

III. Individual Certification: Any individual, who is providing Acceptance, Quality Control, Quality Assurance or Independent Assurance testing of materials and/or acceptance inspection in the areas designated by this program shall be certified.

A. Certification will be required for all personnel who will be performing Materials Testing or Project Inspection in the following areas:

1. Materials Testing:
   a) Soils - SD 103, 104, 105, 106, 108, 110 & 114.

   b) Aggregate - SD 201, 202, 203, 206, 207, 208, 211, 213, 214, 218 & 219.

   c) Asphalt - SDDOT QC/QA Asphalt Concrete Certified Technician Level - II - SD 108, 201, 202, 206, 207, 208, 211, 213, 214, 220, 301, 312, 313, 314, 315, 316, 317 & 502.

   SDDOT QC/QA Asphalt Concrete Certified Technician Level - IV - Requires successful completion of QC/QA Level II as prerequisite and includes SD 209, 210 & 309. Contractors or Consultants doing mix designs for the South Dakota Department of

Transportation must participate in the Department's Round Robin Proficiency Sample Program.

SDDOT Superpave Asphalt Concrete Certified Technician Level - SP - Requires successful completion of QC/QA Level II as prerequisite and includes the following additional tests: T 176, T 304, T 312 & D 4791.

d) ACI Concrete Field Testing Technician - Grade I (As per ACI curriculum).

Or

SDDOT Fresh Concrete Testing - SD 402, 403, 404, 405, 408 & 411.

2. Project Inspection:
   a) Earthwork.
   b) Structures.
   c) Concrete Paving.
   d) Concrete Plants.
   e) Asphalt - SDDOT QC/QA Asphalt Concrete Certified Technician - Level III (with Level I as a prerequisite).
   f) Erosion & Sediment Control

B. Materials Testing Certification: Independent Assurance (IA) testing will be used to monitor accuracy of equipment calibration and uniformity of testing procedures of certified, temporary, or seasonal individuals. The IA test results shall be within the tolerances specified in the Materials Manual or Specifications.

1. Requirements for Permanent Personnel:

   a) Initial certification:
      1) Soils or Aggregate: The individual must successfully complete each segment of the Department's Soils and Aggregate Testing Course.

      Asphalt: Individual must follow the procedures for certification contained in Appendix 3 of this document. The individual must attend the training course and pass the required exams prior to sampling and testing materials associated with asphalt concrete construction. Testing out of the QC/QA Certification Courses will not be allowed.

      Concrete: Individual must be certified as an ACI Concrete Field Testing Technician – Grade I prior to sampling and testing concrete. Testing out of the ACI Certification Course will not be allowed.

      NOTE: Individuals previously certified through the Departments Fresh Concrete Tests Course will be allowed

to provide testing, however; they will be required to be re-certified under the ACI curriculum before their current certification expires or by 2008.

2) Permanent SDDOT employees, who will be sampling and testing materials for acceptance, are expected to become certified in at least one material testing area within one year of their date of hire. Until an individual is certified, they shall function in accordance with the parameters established for temporary or seasonal personnel.

3) All of the Materials Testing certifications are valid for 4 years (except the ACI Certification which is valid for 5 years), after which time the individual must become recertified before the expiration date of the current certification.

b) Recertification:

1) Soils or Aggregate: Recertification must be accomplished by successfully completing the course with Performance Exams or successfully completing the Re-certification process with Performance Exams on an alternating basis every 4 years and before the expiration date of the current certification. Re-certification process can be scheduled through the Region Materials Engineers Office.

Participation in conducting any of the Department sponsored Certification courses as a trainer, will fulfill the requirement for certification or recertification for that course for a period not to exceed four years.

2) Asphalt: Individual must follow the procedures for recertification contained in Appendix 3 of this document.

3) Concrete: Individuals certified by ACI and/or the Departments Fresh Concrete Tests Course must follow the current ACI procedures to become recertified.

2. Requirements for Temporary & Seasonal Personnel:

a) Temporary and seasonal personnel who are utilized to perform materials testing duties shall obtain a copy of the test procedure(s) and become familiar with them.

b) Shall observe a certified technician perform the test procedure.

c) Shall perform the test procedure until proficiency is achieved.

d) Shall demonstrate the test procedure to a certified technician. The certified technician shall use the Performance Checklist for the test being demonstrated to ascertain all steps are performed correctly. This document shall be retained as verification of successful demonstration of the procedure.

e) Shall have a copy of the applicable test procedure available during the demonstration testing and while testing material on the project.

f) Shall work on the same project under direct supervision of an individual certified in that area of testing.

g) A copy of the Performance Checklist for the test(s) in which a Temporary or Seasonal individual has demonstrated proficiency and the Training & Evaluation Record document for all non-DOT personnel used on a project shall be available for review in the Project File at the Area Office and in the laboratory on the project. These records for Temporary or Seasonal DOT Personnel shall be available for review at the Area office.

h) Individuals must be certified as an ACI Concrete Field Testing Technician – Grade I or have been previously certified in the Departments Fresh Concrete Tests Course prior to sampling and testing concrete.

C. Inspection Certification: The responsible SDDOT Area Engineer shall monitor certified individuals providing inspection on projects and take appropriate action for non-conformance according to guidelines established by the SD Bureau of Personnel for SDDOT employees or the terms of the contract for consultants, contractors, or others.

1. Requirements for Permanent Personnel:

a) Initial Certification:

1) Asphalt Inspections: Individual must follow the procedures for certification contained in Appendix 3 of this document. The individual must attend the training course and pass the required exams prior to inspection of asphalt concrete. Testing out of the Certification Courses will not be allowed for technicians who obtained their certification in South Dakota. Technicians currently certified in a surrounding state have the opportunity to test out in Level I and III.

2) All Other Inspection Areas: Permanent SDDOT employees, who will be performing acceptance inspection, are expected to become certified in at least one inspection area within one year of their date of hire. Until they become certified, they shall function in accordance with the parameters established for temporary or seasonal personnel.

3) Certifications are valid for four years, after which the individual must become recertified before the expiration date of the current certification.

b) Recertification:

1) Asphalt Inspections: Individual must follow the procedures for recertification contained in Appendix 3 of this document.

2) All Other Inspection Areas: Recertification must be accomplished by completing the re-certification process or successfully completing the course on an alternating basis every 4 years and before the expiration date of the current certification. Contractors and Consultants need to contact the Region Materials Engineers office nearest their area to sign up for re-certification courses.

2. Requirements for Temporary & Seasonal Personnel:

a) An individual's qualifications (training, education, and experience) will be considered in determining their ability to provide proper inspection in a particular area.
b) The individual must work on the same project under direct supervision of an inspector certified in that inspection area.
c) The certified inspector will determine whether the temporary or seasonal person is qualified for a particular area of inspection.
d) The individual shall review the applicable Training Manual and have it available for use on the project.
e) Temporary or seasonal personnel will not be required to take any of the inspection certification courses.
f) A copy of the Training & Evaluation Record document showing the area(s) in which a Temporary or Seasonal individual has demonstrated proficiency for inspection for non-DOT personnel used on a project shall be available for review in the Project File at the Area Office and on the project. These records for Temporary or Seasonal DOT Personnel shall be available for review at the Area Office.

D. Responsibilities - Material Testing:

1. Materials & Surfacing Program shall:
a) Administer IA materials testing courses. Administer proficiency testing and exams to Region Materials personnel or any other individuals performing Independent Assurance testing.
b) Administer "Proficiency Sample" testing program to assure uniformity in test results of those doing Independent Assurance testing, when deemed necessary.
c) Maintain a list of Certified Individuals.
1) Retain records (exams) for three years.
2) Create and maintain a current database of all certification records.
3) Provide a letter of notification within 7 calendar days of the examination, to all individuals who fail to achieve a passing score. (A copy of this letter will be provided to the Area

Engineer and the Region Materials Engineer for DOT employees or to the Employer and Region Materials Engineer if the individual is not a DOT Employee.)

4) Provide each individual with a certificate signifying successful completion of a course within 30 calendar days of the date of the test.
5) Provide each individual a card at the beginning of the construction season indicating the areas in which they are certified and the expiration date of each certification.
6) At the beginning of each construction season, provide the Operations and Area Engineers with a tabulation of the personnel in their respective Regions/Areas that are certified, along with the expiration dates for those certifications.
7) Distinguish between the types of exam given to the individual (re-test, re-certification, provisional, or course exam) for each certification area.

2. Region Materials
   a) Monitor certified individual's test procedures and comparison results through Independent Assurance testing.
   b) Verify temporary and seasonal personnel test procedures and comparison results through Independent Assurance testing.
   c) Administer and grade the written and performance re-certification and re-test exams for Soils & Aggregate Testing and applicable QC/QA levels to Area Office personnel, Contractors, Consultants, and other entities.
   d) Notify Area Office, Consultant, Contractor, or other entity of an individual's substandard test procedures or comparison results.

3. Area Office
   a) Insure projects are staffed with properly certified Area personnel and verify Contractor, Consultant, or other Entity personnel are certified in the area in which they are working.
   b) Responsible for sending their individuals to the appropriate training.
   c) Qualify SDDOT temporary and seasonal employees annually.
   d) Maintain documentation of seasonal qualifications on *Training and Evaluation Record* (Record 4).
   e) Insure that Certified Personnel are meeting the supervision requirements for temporary or seasonal personnel.
   f) Take appropriate action when notified of an individual's substandard test procedure or comparison results.

4. Contractors, Consultants & Other Entities
   a) Responsible for sending their individuals to the appropriate training.
   b) Insure properly certified individuals staff the project.
   c) Qualify their own temporary and seasonal employees annually.

d) Maintain documentation on seasonal qualifications on *Training and Evaluation Record* (Figure 3).
e) Take appropriate action when notified of an individual's substandard test procedures or comparison results.
f) Have a copy of the Equipment Calibration Records for all Testing equipment used on the project available for review in the Project Files at the Area Office and also in the testing laboratory on the project.

5. Certified Individual
a) Insure he/she works only in the areas for which he/she has been certified.
b) Insure that certifications are kept current.
c) Insure the material tests are performed in accordance with the material test procedures and material test results are reported to the required precision.
d) Insure the equipment has been calibrated and properly maintained.
e) Insure all necessary equipment calibration records are complete and on file.
f) Insure that test samples are retained for the specified period of time. When a time period is not specified, passing samples shall be disposed of in a safe and expeditious manner after the testing is complete and the test results have been approved. Insure that applicable State or Federal guidelines or regulations for the disposal of materials are strictly adhered to.
g) Insure work is accomplished in an ethical manner.
h) Each Certified Individual will be allowed to supervise a maximum of 2 temporary or seasonal employees in an area in which they are certified.
i) The Certified Individual will be responsible for overseeing the temporary or seasonal employee's work and initial any reports.
j) Take corrective action when notified of substandard testing procedures or comparison results.

E. Responsibilities - Inspection

1. SDDOT Central Office personnel will:
a) Assist in the development of the training material and/or provide training for the inspection and testing classes.
b) Insure exams are graded by the Lead Instructors.
c) Materials and Surfacing Program will maintain a List of Certified Individuals in each of the inspection areas.
1) Retain records (exams) for three years.
2) Create and maintain a current database of all certification records.
3) Provide a letter of notification within 7 calendar days of the examination, to all individuals who fail to achieve a passing score. (A copy of this letter will be provided to the Area Engineer and the Region Materials Engineer for DOT

employees or to the Employer and Region Materials Engineer if the individual is not a DOT Employee.)

4) Provide each individual with a certificate signifying successful completion of a course within 30 calendar days of the date of the test.
5) Provide each individual a card at the beginning of the construction season indicating the areas in which they are certified and the expiration date of each certification.
6) At the beginning of each construction season, provide the Operations and Area Engineers with a tabulation of the personnel in their respective Regions/Areas that are certified along with the expiration dates for those certifications.

2. Region Materials
   a) Administer and grade the re-certification and re-test exams for the various inspection areas to Area Office personnel, Contractors, Consultants, and other entities.

3. Area Office
   a) Insure projects are staffed with properly certified Area personnel and verify Contractor, Contractor, Consultant & Other Entities' personnel are certified in the inspection area in which they are working.
   b) Responsible for sending their individuals to the appropriate training.
   c) Verify SDDOT temporary and seasonal employee inspection proficiency.
   d) Maintain documentation of seasonal qualifications on *Training and Evaluation Record* (Figure 3).
   e) Insure that Certified Personnel are meeting the supervision requirements for temporary or seasonal personnel.
   f) Take appropriate action when notified of an individual's substandard work.

4. Contractors, Consultants & Other Entities
   a) Responsible for sending their individuals to the appropriate training.
   b) Insure properly certified individuals staff the project.
   c) Verify temporary and seasonal employee inspection proficiency.
   d) Maintain documentation of seasonal qualifications on *Training and Evaluation Record* (Figure 3).
   e) Take appropriate action when notified of an individual's substandard work.

5. Certified Individual
   a) Insure he/she works only in areas for which he/she has been certified.
   b) Insure that certifications are kept current.

c) Insure inspections are conducted to verify compliance with plans and specifications and that proper documentation is made.
d) Insure work is accomplished in an ethical manner and non-specification work is properly documented and reported to the Area Engineer.
e) Qualify temporary & seasonal employees based on education, experience, and/or successful completion of exam.
f) Each Certified Inspector will be allowed to directly supervise a maximum of 2 temporary or seasonal employees in an area in which they are certified.
g) The Certified Inspector will be responsible for overseeing the temporary or seasonal employee's work and shall initial any reports.
h) Take corrective action when notified of substandard work.

F. Conflict of Interest:

In order to avoid a conflict of interest, no individual or laboratory shall perform more than one of the following types of testing on the same project:

- Acceptance Testing
- Quality Control Testing
- Quality Assurance Testing
- Independent Assurance Testing
- Dispute Resolution Testing

Note: The Region Materials Laboratory may perform Dispute Resolution Testing on QC/QA projects.

G. Dispute Resolution Testing: Dispute resolution testing of materials shall be accomplished by the SDDOT Central Testing Laboratory, AASHTO Accredited Laboratories, Region Materials Laboratory or other SDDOT Approved Accredited Laboratories.

H. Suspension/Revocation of Certification: Any suspension or revocation of an individual's certification shall be administered by the Oversight Committee. A meeting of the Oversight Committee may be called at any time by the Chair of the committee or by a written request to the Chair by at least three committee members. A majority of the members shall be present for the transaction of official business.

1. Oversight Committee members are:
   a) Chief Materials & Surfacing Engineer - Chair.
   b) Director of Operations.
   c) SDDOT Chief Engineer.
   d) Certification/Accreditation Engineer.
   e) Pavement and Materials Engineer, FHWA.
   f) One Region Operations Engineer rotated on a 2 year basis.
   g) One Area Engineer rotated on a 2 year basis.

h) Consultant Engineering Firm representative - appointed by the Chair serving a 2 year term.
i) Region Materials Engineers

2. Oversight Committee responsibilities:
   a) The committee at minimum will meet once a year to review and update the Materials Testing & Inspection Certification Program Manual and applicable policies.
   b) Investigate and resolve (majority vote) written allegations of misconduct. Allegations of misconduct shall be made to the Chair of the Oversight Committee in writing. The allegation shall contain the name, phone number, address, and signature of the individual(s) making the allegation. The allegations will be investigated by the Oversight Committee. If warranted, the accused and the individual(s) making the allegation will be given the opportunity to appear before the Oversight Committee to resolve the allegation. The Chair of the Oversight Committee will provide written notification to all of the involved parties of the decision of the Oversight Committee. Any warranted penalties may be imposed as determined by the Oversight Committee.

      For just cause the Oversight Committee may impose suspension or revocation of an individual's certification at any time. The reasons that an individual will be subject to revocation or suspension of their certification are falsification of records/tests/reports, negligence, or abuse of their responsibilities. The Oversight Committee may also suspend or revoke an individual's certification for other reasons of just cause, which may or may not be specifically defined.

      Negligence is defined as repeated unintentional deviations from approved procedures, which may or may not cause erroneous results. A reoccurring finding of negligence will result in a letter from the Oversight Committee to the Employer directing them to write a letter of reprimand to the individual. A continuing finding will result in a thirty (30) day suspension of the individual's certification. Any subsequent finding will be treated as abuse.

      Abuse is defined as intentional deviations from approved procedures. (Examples of abuse include, but are not limited to: the falsification of test results or records, submittal of false information on certification applications, and/or unwillingness to follow prescribed test procedures.). The first instance of abuse shall result in a one (1) year suspension of an individual's certification. Any subsequent finding of abuse shall result in the permanent revocation of the individual's certification.

      Any findings of abuse or negligence warranting the revocation or suspension of an individual's certification will result in the

revocation or suspension of all certifications held by that individual in the various Material Testing or Inspection Areas. When the suspended individual is reinstated and prior to performing work, the individual will be required to pass the written and/or performance re-certification exams, as applicable, and the individual's recertification expiration date(s) will be that expiration date(s) held prior to the suspension.

Falsification of records/tests/reports: Any person who knowingly makes any false statements of records/tests/reports as to the quantity, quality, or cost of the material used on, or the work performed on any federal-aid project is also subject to be fined or imprisoned in accordance with Title 18, United States Code Section 1020.

c) Investigation and resolution (majority vote) of any appeals of exam scores due to ambiguous question(s) or problem(s) with the training course exam(s). For just cause the Oversight Committee may adjust an exam score of an individual, if investigation and resolution of the written request warrants such action. The individual must provide a written appeal with the justification(s) why the question(s) or problem(s) was/were ambiguous within 60 calendar days from the date of the exam.

d) The Oversight Committee will notify the employer of all actions taken.

e) Other duties as required to successfully implement and continue the Certification Program.

I. Reciprocity: Reciprocity may be allowed for soil and aggregate material testing only. The individual's qualifications will be reviewed by the Materials and Surfacing Program to see if the meet SDDOT standards of material testing. Reciprocity will not be granted for inspection certification or asphalt and concrete material testing certification.

IV. Exams

A. Types of Exams:

1. Written Exams:
   a) Types of written exams:
      1) Course Exam.
      2) Re-test Exam.
      3) Re-certification Exam.
      4) Provisional Exam.
   b) Exams will be open book unless precluded by the approved testing entity.

c) A minimum overall score of 70% on the written exam shall be obtained to successfully pass the written exam.

d) If the written exam is failed, the individual will be given one more opportunity to pass another written exam. The re-test exams will be scheduled at the convenience of the Region Materials Engineer and within 30 calendar days of the original written exam. *NOTE: The Region Materials Engineer cannot administer a re-test for the ACI course. This re-test must be rescheduled with a duly authorized ACI representative.* If a re-test is failed, the individual will not be allowed to provide inspection, acceptance testing, or independent assurance testing for that certifiable area until the individual has taken the appropriate class and successfully completed the written exam(s).

NOTE: Any individual failing the written exam in an attempt to become re-certified will not be allowed to re-test and will be required to attend the appropriate class and successfully complete the written exam before being allowed to provide inspection, acceptance testing or independent assurance testing for that certifiable area. Individuals failing the written and/or performance exam(s) may be utilized to provide inspection and acceptance testing provided t he rules under "Requirements for Temporary & Seasonal Personnel" are followed and only at the discretion and approval of the Region Materials Engineers.

2. Performance Exams:

a) Types of Performance Exams:
   1) Course Performance Exam.
   2) Re-test Performance Exam.
   3) Re-certification Performance Exam.
   4) Provisional Performance Exam.

b) The individual will be required to demonstrate and/or explain the material test procedure as determined by the testing agency.

c) Individuals shall successfully complete all of the items covered on the checklist for each test method within the test procedure time restraints. The omission of one or more of the prescribed procedures will constitute failure of the performance test method. The individual will be allowed two trials on the day of the performance examination for each test procedure. Failure of any one of the prescribed tests after two trials will constitute failure of the entire performance exam. Grading of the performance exam is on a Pass/Fail basis.

d) Any individual failing the performance exam on the day of the examination has the opportunity to retake another exam at the scheduling convenience of the department.

e) If the individual fails the performance exam a second time, they will not be allowed to provide testing in that certifiable area until the individual attends the appropriate class and successfully completes the exam(s).

NOTE: Any individual failing a performance exam in an attempt to become re-certified will not be allowed to re-test and will be required to attend the appropriate class and successfully complete the performance exam before being allowed to provide inspection, acceptance testing or independent assurance testing for that certifiable area. Individuals failing the written and/or performance exam(s) may be utilized to provide inspection and acceptance testing provided the rules under "Requirements for Temporary & Seasonal Personnel" are followed and only at the discretion and approval of the Region Materials Engineers.

B. Requirements:

1. Materials Testing Certification:
   a) Pass Written Exam.
   b) Pass Performance Exam.

2. Inspection Certification:
   a) Pass Written Exam.

V. Training

A. Certification Courses: Courses will be provided by SDDOT or other SDDOT approved entities. Each individual attending any of the training courses or test outs shall furnish their social security number. The social security number will be used as the key identifier for tracking each individual's certification record.

B. Instructors: SDDOT will provide instructors or other authorized individuals to teach the courses.

C. Enrollments: The South Dakota Bureau of Personnel (BOP) Training Program will support the SDDOT in maintaining course enrollment information and provide printed rosters to be e-mailed to the instructors. The instructors shall provide an accurate roster of those attendees actually at the course to the SDDOT Materials & Surfacing Program at the completion of each course.

1. SDDOT Employees: DOT approving authority will send an e-mail requesting attendance at the training to the Department's Personnel Assistant at the Personnel Office who will forward the request to TRAINING REGISTRATION (an e-mail address). The enrollment information includes: Employee name, department, employee work address, employee's or supervisor's phone number, employee's social security number/employee's identification number/employee's drivers license number, organization MSA number, and course title, date, & location. Confirmation of enrollment and the AFE number is sent to the DOT approving authority.

2. Non-DOT Persons: The DOT/BOP will announce the course prerequisites, cost, date(s), and time to the Non-DOT target audience. The company can enroll their personnel in the training course by e-mail to ctr@state.sd.us or letter through the mail. Enrollment information includes: employee name, company, company billing address, employee work address, employee's or supervisor's phone number, employee's social security number or drivers license number, and course title, date, & location. Confirmation of enrollment will be sent to the employee's supervisor or company.

3. Attendance Cancellation Policy: If the individual enrolled in the course cannot attend the training, the individual, supervisor, or company is required to cancel their registration at least 24 hours prior to the start of the training course. To cancel an individual from the training course call (605) 773-3461. Failure to cancel will result in a no show and deprive a person on the waiting list from being able to attend.

D. Training Costs: The SDDOT will determine the cost of the training course for those they are conducting. Other training entities (ACI, Erosion & Sediment Control & Asphalt QC/QA) will determine the cost of the training that they provide. These costs will be provided in the course announcements. The cost of training manuals may be billed separately.

E. Contractor, Consultant, or Other Entities:

1. Shall pay for training courses and manuals as outlined above.
2. Shall be charged for certification course enrollees who do not show at the training class. A refund of the registration fee(s), if prepaid, will be granted if the class is canceled by the SDDOT. If notified on the day of the training that an individual is unable to attend due to inclement weather or good cause (605-773-3461), the registration fee may be refunded.

File: Outline3.doc

PROCEDURE FOR CALIBRATING EQUIPMENT

Equipment Checked:

SIEVES Fine (M-92 E-11) SD 202 Procedure #6

Purpose:

This method provides instructions for checking the physical condition of laboratory test sieves ranging in size from 3" to the #4 and visually from the #8 to the #200.

Inspection Equipment Required:

1. Caliper readable to 0.0001" or 0.01 mm.

Tolerance:

Sieves shall meet the physical requirements in the test methods listed above.

Procedure for 3" to #4

1. Measure and record three different openings along a 45 degree angle.
2. Verify that the openings are within tolerance.

Visual inspection for sieves finer than #4

1. Inspect the general condition for waviness, dents, scratches or looseness. Record findings.

12/96

Figure 1 - Example of a Procedure for Calibrating Equipment

EQUIPMENT CALIBRATION RECORD

Date: _____ Calibr. By: _____

Equipment: COARSE SIEVES (M-92) SD 202 PROCEDURE #6

Calibration Due: _____ Next Due: _____

Previous Calibr. Date: _____ Frequency: _____

Calibration Equipment and Serial Number:

_____ _____

				Action Recommended	
Sieves	**Specification (mm)**	**Serial No. or I.D. No.**	**Reading**	**Accept**	**Replace**
3" (75 mm)	72.8 - 77.2				
2-1/2" (63 mm)	61.1 - 64.9				
2" (50 mm)	48.5 - 51.5				
1-1/2" (37.5 mm)	36.4 - 38.6				
1-1/4" (31.5 mm)	30.5 - 32.5				
1" (25.0 mm)	24.2 - 25.8				
3/4" (19.0 mm)	18.4 - 19.6				
5/8" (16.0 mm)	15.5 - 16.5				
1/2" (12.5 mm)	12.11 - 12.89				
3/8" (9.5 mm)	9.2 - 9.8				
5/16" (8.0 mm)	7.75 - 8.25				
1/4" (6.3 mm)	6.1 - 6.5				
#4 (4.75 mm)	4.6 - 4.9				
#5 (4.00 mm)	3.87 - 4.13				

Figure 2 - Example of a Record for Calibrating Equipment

SDDOT MATERIAL TESTING & INSPECTION CERTIFICATION PROGRAM

Training and Evaluation Record

Seasonal or Temporary Employee Name: ____________________ SSN: __________________

Test Method and Inspection	Check One		Evaluated By	Title	Date	Comments
	Pass	Fail				

Figure 3

APPENDIX 1

SOUTH DAKOTA DEPARTMENT OF TRANSPORTATION
REGION AND FIELD LAB/AREA
EQUIPMENT CALIBRATION AND VERIFICATION LIST
Revised April 13, 2006
BITUMINOUS MATERIALS AREA

APPARATUS	REQUIREMENT	**IA** REGION CALIBRATION & VERIFICATION FREQUENCY	**ACCEPTANCE** FIELD LAB/AREA CALIBRATION & VERIFICATION FREQUENCY	TEST METHOD	PROCEDURE NUMBER
Ovens	Verify Settings.	12 mo.	Prior to use on proj.		02
Sieves					
Coarse	Check physical condition.	12 mo.	12 mo.	M-92	06
Fine	Check physical condition.	12 mo.	12 mo.	M-92	06
Vacuum System	Check pressure.	12 mo.	12 mo.	T-209, T-100	09
Marshall Hammer	Check critical dimensions and weight of hammer.	12 mo.	24 mo.	T-245, SD 313	16
Mechanical Marshall Hammer Correlation	Calibrate.	36 mo.	36 mo.	T-245, SD 313	17
Marshall Molds & Breaking Head	Check critical dimensions.	12 mo.	24 mo.	T-245, SD 313	30
Mechanical Shaker (Thoroughness)	Check sieving thoroughness.	12 mo. Permanent Locations	24 mo. Permanent Locations	T-27, SD 202	40
Thermometers	Calibrate.	12 mo.	Prior to use on proj.		44
Balances and Scales	Verify.	12 mo. Perm. Loc.	Prior to use on proj.	M-231	45
Gyratory Molds, Ram Heads & Base Plates	Check critical dimensions.	12 mo.	12 mo.	T 312	49
Gyratory Compactor	Calibrate	12 mo.	12 mo.	T 312	78

SOUTH DAKOTA DEPARTMENT OF TRANSPORTATION
REGION & FIELD LAB/AREA
EQUIPMENT CALIBRATION AND VERIFICATION LIST
Revised April 13, 2006
SOIL AND AGGREGATE AREA

APPARATUS	REQUIREMENT	**IND. ASSURANCE** CALIBRATION & VERIFICATION FREQUENCY	**ACCEPTANCE** CALIBRATION & VERIFICATION FREQUENCY	TEST METHOD	PROCEDURE NUMBER
Ovens	Verify temperature settings.	12 mo.	Prior to use on proj.		02
LA Abrasion Machine & Steel Spheres	Check weight & critical dimensions.	24 mo.	24 mo. *	T-96	03
Handheld Rammer (Proctor)	Check weight & critical dimensions.	12 mo.	36 mo.	T-99, T-180, SD 104	04
Molds (Proctor)	Check critical dimensions.	12 mo.	36 mo.	T-99, T-180, SD 104	05
Sieves					
Coarse	Check physical condition.	12 mo.	12 mo.	M-92	06
Fine	Check physical condition.	12 mo.	12 mo.	M-92	06
Liquid Limit Device & Grooving Tool	Check wear & critical dimensions.	12 mo.	12 mo.	T-89, SD 207	15
Specific Gravity Apparatus (Coarse Agg)	Check critical dimensions.	12 mo.	12 mo. *	T-85, SD 210	23
Sodium Sulfate Oven	Check evaporation rate.	12 mo.	12 mo. *	T-104	28
Conical Mold & Tamper	Check critical weights & dimensions.	24 mo.	24 mo. *	T-84, SD 209	33
Mechanical Shakers (Thoroughness)	Check sieving thoroughness.	12 mo. Permanent Locations	24 mo. Permanent Locations	T-27, SD 202	40
Thermometers	Calibrate.	12 mo.	Prior to use on proj.	T-88, T-100	44
Balances and Scales	Verify.	12 mo. Perm. Loc.	Prior to use on proj.	M-231	45
Mechanical Rammer (Proctor)	Check weight & critical dimensions.	12 mo.	12 mo.	T-99, T-180, SD 104	67
Rubber Balloon Density Apparatus	Calibrate.	12 mo.	12 mo.	T-205, SD 106	68
Specific Gravity Flasks	Calibrate.	12 mo.	12 mo. *	T-84, SD 209	69
Straightedge	Check critical dimensions & planeness of edge.	12 mo.	36 mo.	T-99, T-180, SD 104	70
Sand Equivalent Apparatus	Check critical dimensions.	12 mo.	12 mo.	T-176	75

***Additional Calibration required for QC/QA Asphalt Mix Designs**

SOUTH DAKOTA DEPARTMENT OF TRANSPORTATION
REGION & FIELD LAB/AREA
EQUIPMENT CALIBRATION AND VERIFICATION LIST
Revised April 13, 2006
CONCRETE AREA

APPARATUS	REQUIREMENT	**IA** REGION CALIBRATION & VERIFICATION FREQUENCY	**ACCEPTANCE** FIELD LAB/AREA CALIBRATION & VERIFICATION FREQUENCY	TEST METHOD	PROCEDURE NUMBER
Unit Weight Measures	Calibrate.	12 mo.	36 mo.	T-19, T-121, SD 204, SD 205	07
Compression Machine Bearing Blocks	Verify depart. from plane.	12 mo.	12 mo.	T-22	11
Slump Cones	Check critical dimensions.	12 mo.	Prior to use on proj.	T-119, SD 404	38
Concrete Cylinder Molds (Single Use)	Check dimensions.	Each Shipment	Each Shipment	T-22, M-205, SD 405	43
Balances and Scales	Verify.	12 mo. Perm. Loc.	Prior to use on proj.	M-231	45
Compression Testing Machine	Verify.	12 mo.	12 mo.	T-22	45
Air Meter Pressure (Type A)	Calibrate.	Cal. on proj. due to elev. changes	Prior to use on proj.	T-152, SD 403	59
Concrete Cylinder Molds (Reusable)	Check dimensions.	12 mo.	36 mo.	T-22, M-205, SD 405	71
Air Meter Pressure (Type B)	Calibrate.	Cal. on proj. due to elev. changes	Prior to use on proj.	T-152, SD 403	72

Appendix 2

LISTING OF REGION & FIELD LAB CALIBRATION PROCEDURES April 13, 2006

EQUIPMENT	PROCEDURE #	RECORD #
OVENS	02	02
L.A. ABRASION MACHINE & STEEL SPHERES	03	03
HANDHELD RAMMER (PROCTOR)	04	04
MOLDS (4" AND 6" PROCTOR)	05	05
SIEVES (COARSE)	06	06-C
SIEVES (FINE)	06	06-F
UNIT WEIGHT MEASURE	07	07
VACUUM SYSTEM	09	09
COMPRESSION MACHINE BEARING BLOCKS	11	11
LIQUID LIMIT DEVICE & GROOVING TOOL	15	15
MARSHALL HAMMER	16	16
MECHANICAL MARSHALL HAMMER CORRELATION	17	17
SPECIFIC GRAVITY APPARATUS (COARSE AGG)	23	23
SODIUM SULFATE OVEN	28	28
MARSHALL MOLD	30	30
CONICAL MOLD & TAMPER	33	33
SLUMP CONE	38	38
MECHANICAL SHAKER (THOROUGHNESS)	40	40
CONC. CYL. MOLDS (SINGLE USE)	43	43
THERMOMETERS	44	44
SCALES, BALANCES, ANALYTICAL BALANCES, LOAD CELLS & COMPRESSION MACHINES	45	45
GYRATORY MOLDS, RAM HEADS & BASE PLATES	49	49
AIR METER PRESSURE (TYPE A)	59	59
MECHANICAL RAMMER (PROCTOR)	67	67
RUBBER BALLOON DENSITY APPARATUS	68	68
SPECIFIC GRAVITY FLASKS	69	69
STRAIGHTEDGE	70	70
CONC. CYL. MOLDS (REUSABLE)	71	71
AIR METER PRESSURE (TYPE B)	72	72
SAND EQUIVALENT APPARATUS	75	75
GYRATORY COMPACTOR	78	78

Appendix 3

SOUTH DAKOTA DEPARTMENT OF TRANSPORTATION ASPHALT CONCRETE QUALITY CONTROL / QUALITY ASSURANCE CERTIFICATION PROGRAM

1. SCOPE:

The purpose of this program is to develop and maintain a pool of well-trained technicians for the Department and its contractors, and to test and manage highway construction materials. The intent of this program is to improve the quality and performance of hot mixed asphalt pavements through knowledge and understanding of the products.

2. CERTIFICATION LEVELS:

Bituminous Technology I	Introduction to Asphalt (Basic Introduction)
Bituminous Technology II	Bituminous Laboratory Testing (Hands On Laboratory Training)
Bituminous Technology III	Roadway Inspection and Compaction (Field Inspection)
Bituminous Technology IV	Asphalt Concrete Production Control (Mix Design)
Bituminous Technology SP	Superpave Laboratory Testing (Hands On Laboratory Testing)

Level I is a prerequisite to all other levels. Level I can be followed by either Level II or Level III. Levels I, II, and III are prerequisites to Level IV. Level I and Level II are prerequisites to Superpave.

3. CERTIFICATION STANDARDS:

When the South Dakota Department of Transportation specifications require Quality Control / Quality Assurance testing, those technicians performing the sampling and testing must be certified in South Dakota. Certification may be attained in one of the following ways:

A. Technicians currently certified in a surrounding state have the opportunity to test out of Bituminous Technology Levels I and III. The candidate may request to test out of these specific certification levels by requesting in writing to the Chief South Dakota Department of Transportation Materials and Surfacing Engineer their desire to test out. The candidate must furnish documented work history showing that the candidate has been involved in the specific work area the past four years that relates to the certification level and have a current applicable certification level from one of the surrounding states.

B. Candidates not currently certified in a surrounding state, or not eligible to test out, must attend the certified training course.

   1. As a prerequisite to attending the certified training course, the candidate must exhibit basic mathematics and comprehensive reading skills.

2. The candidate shall successfully complete the classroom and laboratory evaluations if the course requires a laboratory evaluation.

   a. Laboratory Evaluation – Candidates must successfully perform in the presence of a qualified evaluator, all necessary tests required to control hot mixed asphalt mixtures as outlined in the course manual.

   b. Classroom Evaluation – Each candidate shall successfully pass a written examination administrated by a qualified evaluator.

      i. Successfully passing the written examination shall be defined as scoring a minimum of 70 percent.

      ii. A candidate failing the written examination shall be given the opportunity to retest within a period of thirty (30) days. There will be no charge for the retest.

      iii. Failure to pass the retest shall be considered as failing the entire course. Students still desirable of becoming certified must retake the entire course.

3. No refund of course fees will be made for failure to successfully complete the course.

C. Provisional Certification may be allowed under special circumstances.

1. The applicant's employer, whether SDDOT or contractor, must include the circumstances for the needed provisional status. These circumstances must outline the reasons for application and should be detailed enough for the Certification Advisory Committee to understand the organizational need for provisional certification.

2. A prior work history of the applicant must accompany the request for provisional status.

3. Whoever is applying for a Level II, Level III or Superpave provisional certification must pass the test for the area of work they are going to perform. This test would be administered by the SDDOT at a site arranged with the applicant and a specific SDDOT office.

4. If the applicant successfully passes the test, they must work under the direction of a Level II, Level III or Superpave certified individual for a period of not less than 2 days to ascertain familiarity with the project requirements and appropriate tests and procedures.

5. Provisional Certification is only valid for one (1) calendar year.

4. CERTIFICATION:

Final certification shall be contingent upon the applicant passing all course requirements. The SDDOT Materials and Surfacing Accreditation Engineer in Pierre shall maintain records of certification. Candidates are responsible for assuring that they work only in areas in which they are certified, that their certification does not expire, and that they are able to provide proof of certification when requested.

5. RECERTIFICATION:

A technician's certification is valid for not more than four (4) years, after which they must be recertified. Recertification can be accomplished in one of the following ways to determined by the Certification Advisory Committee.

A. The candidate for recertification must furnish documentation to the Certification Advisory Committee that he or she has consistently performed the required tests for the previously certified period. A refresher course will be held which will consist of ½ to 1 day of classroom/lab instruction and a test for recertification.

B. The candidate for recertification can take and pass a Level IV certification class and will then be certified at the lower certification levels including Level II, Level III & Superpave. The Level II, Level III and Superpave expiration dates will be revised to reflect the Level IV expiration date.

C. A candidate may retake and successfully complete the certification course at an interval of not more than four (4) years.

After successful recertification, the technician will be fully certified for an additional four (4) year period.

6. DECERTIFICATION:

For just cause, the Certification Advisory Committee may impose suspension or revocation of an individual's certification at any time. An individual may be subject to revocation or suspension of their certification based on falsification of records/tests/reports, negligence, or abuse of their responsibilities. The Certification Advisory Committee may also suspend or revoke an individual's certification for other reasons of just cause, which may or may not be specifically defined. Two levels of misconduct which may result in decertification, along with the associated penalties, are defined as follows:

1. Negligence: Negligence is defined as repeated unintentional deviations from approved procedures, which may or may not cause erroneous results. A reoccurring finding of negligence will result in a letter from the Certification Advisory Committee to the Employer directing them to write a letter of reprimand to the individual. A continuing finding will result in a thirty (30) day suspension of the individual's certification. Any subsequent finding will be treated as abuse.

2. Abuse: Abuse is defined as intentional deviations from approved procedures. (Examples of abuse include, but are not limited to: the falsification of test results or records, submittal of false information on certification applications, and/or unwillingness to follow prescribed test procedures). The first instance of abuse shall result in a one (1) year suspension of an individual's certification. Any subsequent finding of abuse shall result in the permanent revocation of the individual's certification.

Allegations of misconduct shall be made to the Certification Advisory Committee in writing. The allegation shall contain the name, phone number, address and signature of the individual(s) making the allegation. Upon receipt of the written allegation, the Oversight Committee will investigate the matter. If warranted, the accused and the individual(s) making the allegation will be given the opportunity to appear before the Certification Advisory Committee to resolve the allegation. The Chair of the Certification Advisory Committee will provide written notification to all of the involved parties of the decision of the Certification Advisory Committee. Any warranted penalties may be imposed as determined by the Certification Advisory Committee.

Any findings of abuse or negligence warranting the revocation or suspension of an individual's certification will result in the revocation or suspension of all certifications held by that individual in the various Materials Testing or Inspection Areas. When the suspended individual is reinstated and prior to performing work, the individual will be required to pass the written and/or performance certification exams as applicable, and the individual's certification expiration date(s) will be that expiration date(s) held prior to suspension.

7. CERTIFICATION ADVISORY COMMITTEE:

The purpose of the Certification Advisory Committee is to review the certification program on an annual basis or as often as deemed necessary by the Chair of the Committee. They shall provide suggestions for modifications and improvements to the program curriculum and operations; review accusations concerning decertification and make recommendations to the Chief Materials and Surfacing Engineer and determine when refresher courses are needed. The Certification Advisory Committee shall perform other duties as required to successfully implement and continue the certification program. A meeting of the committee may be called at anytime by the Chair of the Committee or by written request of at least 3 members of the Committee. A majority of the members of the Committee shall be present for the transaction of official business.

Membership: The membership of the Certification Advisory Committee shall be composed of the following individuals:

Chair: Construction Engineer
Chief Materials & Surfacing Engineer
Region Representative (appointed by the Chair)
Current Chairman of the AGC Bit/Gravel Committee
Industry Representative (appointed by the AGC Chair)
Industry Representative (appointed by the AGC Chair)
Supplier

8. REGISTRATION:

Registration information for any of the certification levels can be obtained from the Associated General Contractors of South Dakota office in Pierre. Contact the AGC at (605) 224-8689 or their website at sdagc.org for more information.

Section Number 4

Section Number 4

Section Number 4

QC/QA SAMPLING AND TESTING
TABLE OF CONTENTS

TEST NUMBER	ABBREVIATED TITLE
SD 108	Moisture Content Determinations
SD 201	Sampling
SD 202	Sieve Analysis
SD 206	Material Finer than a #200 Sieve
SD 207	Liquid Limit, Plastic Limit, and Plasticity Index
SD 208	Particles less than 1.95 Specific Gravity in Fine Aggregates
SD 209	Specific Gravity and Absorption in Fine Aggregate
SD 210	Specific Gravity and Absorption in Coarse Aggregate
SD 211	Crushed Particles (Fractured Faces)
SD 213	Reducing Samples to Testing Size
SD 214	Particles less than 1.95 Specific Gravity in Coarse Aggregate
SD 220	Sodium Sulfate Soundness of Aggregates
SD 301	Sampling Asphalt Materials
SD 305	Determining Moisture Content in Uncompacted Hotmix
SD 309	Moisture Sensitivity of Compacted Asphalt Concrete Paving Mixtures
SD 312	Theoretical Maximum Specific Gravity of Uncompacted Asphalt Concrete Paving Mixtures
SD 313	Density of Compacted Asphalt Concrete Mixtures by the Marshall Method
SD 314	Daily Asphalt Concrete Binder Content
SD 315	Field Density Determination by the Coring Method
SD 316	South Dakota Asphalt Mix Design Procedure & Flow Chart
SD 317	Procedure for Evaluating Quality Control Tests (Sim/Dissim)
SD 502	Lime Mill Certification and Sampling Hydrated Lime

Moisture Content Determination for Soils and Aggregate

1. Scope:

This test is for determining the moisture content of soils and aggregates by gas pressure, burning with alcohol, drying on a stove or hot plate, drying in a convection or microwave oven, and the nuclear method of in-place moisture tests.

2. Apparatus:

2.1 Calcium Carbide Gas Pressure Moisture Tester Method.

A. A calcium carbide gas pressure moisture (Speedy) tester.

B. Tared scale.

C. Two 1 1/4 " (31.5 mm) steel balls.

D. Cleaning brush and cloth.

E. Calcium Carbide reagent.

F. Two 13 g weights.

G. Reagent scoop.

2.2 Alcohol Burning Method.

A. Pan of sufficient size to contain the sample and allow room for stirring without loss of material.

B. Stirring rod or spoon.

C. Supply of denatured alcohol.

D. Scale or Balance having the capacity to weigh any sample which may be tested utilizing this procedure and readable to the nearest 0.1 gram.

E. Cleaning brush.

F. Gloves.

2.3 Stove Top or Hot Plate Method.

A. Stove or hot plate.

B. Steel plate(s), approximately ¼" (6.3 mm) thick to place between the burner(s) and the sample pan.

C. Pan of sufficient size to contain the material and allow room for stirring without loss of material.

D. Spoon or trowel for stirring the material during the drying process.

E. Scale or Balance having the capacity to weigh any sample which may be tested utilizing this procedure and readable to the nearest 0.1 gram.

F. Gloves.

2.4 Oven Drying Method.

A. Drying Oven – Thermostatically controlled, preferably of the convection forced-draft type, capable of being heated continuously at a uniform temperature of 230° ±9°F (110° ±5°C) throughout the drying chamber.

B. Scale or Balance having the capacity to weigh any sample which may be tested utilizing this procedure and readable to the nearest 0.1 gram.

C. Pan of sufficient size to contain the material and allow room for stirring without loss of material.

D. Stirring spoon or trowel.

E. Gloves.

2.5 Nuclear Method – In-Place Moisture Test.

A. A nuclear moisture/density gauge capable of determining moisture/densities by the direct transmission method and conforming to the requirements of AASHTO T 310.

B. A reference standard for checking equipment operation.

C. Standard moisture and density records for the gauge.

D. A drill rod and combination guide-scraper plate for preparing the test site and punching the hole for the direct transmission probe.

E. A manufacturer's instruction manual for the nuclear gauge.

F. A hammer to drive the drill rod, and a shovel and other tools for site preparation.

2.6 Microwave Oven Method.

A. Microwave oven with vented chamber, variable power controls and put | 06
power rating of 700 watts is adequate.

B. Scale or Balance having the capacity to weigh any sample which may be tested utilizing this procedure and readable to the nearest 0.1 gram.

C. Containers (must be suitable for microwave ovens-i.e., nonmetallic and resistant to sudden and extreme temperature change; porcelain, or glass).

D. Glove or holder for handling hot containers.

E. Spatulas, putty knives and glass rods.

3. Procedure:

3.1 Calcium Carbide Gas Pressure Method.

A. Place 3 scoops of calcium carbide and two 1 1/4" (31.5 mm) steel balls in the chamber of the moisture tester.

The "shelf-life" of Calcium Carbide Reagent is limited, thus it should be used according to the manufacturer's recommendations.

B. Using the tared scale, weigh 26 g sample. If the moisture content of the 26 g sample exceeds the limit of the pressure gauge (20%), a one half sized sample must be used. The percentage indicated on the dial is then doubled. Larger samples can be used for low moisture contents (5% or less).

Two or more 26 g samples can be placed in the "CCGP" moisture tester and the resulting dial reading is divided by the number of 26 g samples used.

Note: This method shall not be used on granular materials having particles large enough to affect the accuracy of the test. In general, any appreciable amount retained on a #4 (4.75 mm) sieve.

C. Place the soil sample in the cap. With the pressure vessel in a horizontal position, insert the cap in the pressure vessel and tighten the clamp to seal the unit, taking care that no carbide comes in contact with the soil until a complete seal is achieved.

D. Raise the moisture tester to a vertical position and tap the side of the vessel with the hand so the soil in the cap falls into the pressure vessel.

E. Hold the vessel in a horizontal position and shake, ensuring that the steel balls rotate around the sides of the vessel to break up the soil lumps. (Never shake end to end or the steel balls may damage the dial orifice.) One minute of shaking should be sufficient for granular soils, while 5 minutes or more may be required for highly plastic soils or shale.

F. Cool the gas. When the needle has STOPPED moving SHAKE THE "SPEEDY" for at least a half minute, in order to cool the gas produced. Read the dial while holding the instrument in a horizontal position at eye level.

G. Record the sample weight and the dial reading on a DOT-35 or a DOT-41.

H. Point the instrument away from the operator and slowly release the gas pressure, then empty the contents. When the sample is dumped, it should be examined for lumps. If the sample is not completely broken down, the test is not valid. Repeat the test, with a new test sample increasing the shaking time by one minute.

I. The pressure vessel should be brushed out and the cap wiped clean after each test.

J. The tester shall be checked by comparison with oven dry samples, at the start of use and at least once per week thereafter, if in constant use.

K. The material for oven drying shall weigh at least 100 g and be weighed to the nearest 0.1 gram.

L. The results of the oven dry moisture test must be within one percentage point for soils and 0.6 of a percentage point for sand.

M. If a discrepancy exists, contact the Region Materials Engineer.

3.2 Alcohol Burning Method.

CAUTION: Care must be exercised not to have alcohol on the hands or area surrounding the container of soil-alcohol slurry in order to minimize the fire danger.

Proper ventilation of the area is required.

A. Obtain a sample of wet material weighing a minimum of 100 grams for soils and a minimum of 500 grams for granular materials.

B. Weigh the wet material, record to the nearest 0.1 g and place in the pan.

C. Stir sufficient denatured alcohol into the sample to form a slurry.

D. Ignite the alcohol and stir to shorten the drying time. Burn off all the alcohol. Repeat the process 2 or 3 times or until successive weighing indicates no reduction in weight, each time burning off all the alcohol.

Be sure the alcohol has burned out before adding more.

E. Weigh the dry soil and record the weight on a DOT-35 or DOT-41 to the nearest 0.1 g.

3.3 Stove Top or Hot Plate Method.

A. Obtain a sample of wet material weighing a minimum of 100 grams for soils and a minimum of 500 grams for granular materials.

B. Weigh the material to the nearest 0.1 gram and dry it to a constant weight. Constant weight is achieved when two successive periods of drying indicate no change in the weight of the material. Check the first two samples tested on a project and an occasional sample thereafter for constant weight, to insure that sufficient drying time is being allowed.

NOTE: The sample usually has been dried to constant weight, when, using a cool metal spoon or spatula, the sample is briefly stirred and there is no evidence of moisture or material sticking to the metal of the stirring instrument.

C. Place the steel plate on the burner of the stove or gas hot plate. Steel plates are not required on electric hot plates. Place the pan holding the material on the steel plate.

D. Stir the material during drying to prevent the temperature of the sample from exceeding 230° ±9°F (110° ±5°C).

E. If it is found that samples dried in an oven and those dried on top of the stove do not give test results that compare satisfactorily, use the oven dried method.

3.4 Oven Drying Method.

A. Obtain a sample of wet material weighing a minimum of 100 g for soils and a minimum of 500 g for granular material. Weigh wet material and record to the nearest 0.1 g.

B. Place in dry, clean pan and place in the oven. Stirring the sample periodically during drying accelerates the process.

C. Dry the material to a constant weight and weigh to the nearest 0.1 gram. Constant weight is achieved when two successive periods of drying indicate no change in the weight of the material. Check the first two samples tested on a project and occasional sample thereafter for constant weight, to insure that sufficient drying time is established for material being tested and apparatus being used.

NOTE: Cool until the container can be handled comfortably with bare hands and the operation of balance or sieves on which sample is placed are not affected by heat convection from material/pan.

3.5 Nuclear Method – In-Place Moisture Test.

A. Calibration of the nuclear meter shall be in accordance with SD 114, paragraph 3.1 B.

B. Select a location for the test where the gauge will be at least 6" (150 mm) away from any vertical projection, at least 10' (3 m) away from any vehicle and at least 30' (10 m) away from another nuclear gauge.

C. Remove material, as necessary, to reach the top of the compacted lift to be tested. Prepare a horizontal area, sufficient in size to accommodate the gauge, using the scraper plate supplied with the gauge, by planing to a smooth condition to obtain maximum contact between the gauge and the material being tested. Make sure the gauge sits solidly on the site without rocking.

D. The maximum depressions beneath the gauge shall not exceed 1/8" (3 mm). Use native fines or fine sand to fill voids and level the excess with the scraper plate. The total areas thus filled with fines or sand should not exceed 10% of the bottom area of the gauge.

E. Place the guide plate on the prepared test site and drive the pin through the guide to a depth at least 2" (50 mm) below the depth of material to be measured. Remove the guide pin by pulling straight up, in order to avoid disturbing the access hole.

F. Place the gauge over the access hole and extend the probe into the hole to the desired depth. Slide the gauge so the probe surface nearest the keypad is in contact with the edge of the hole. Take a one-minute moisture reading and report it on the DOT-35 worksheet.

G. Five tests must be performed using the nuclear gauge on mechanically compacted material and compared against oven dry moisture tests to compute a moisture correction factor. Use the DOT-39 to calculate the correction factor.

NOTE: After the moisture correction is determined, it is applied to all future tests performed with the nuclear gauge. Corrections are not interchangeable between nuclear gauges, and must be individually determined. If unusually high or low moisture content results occur, additional checks shall be completed and documented on a DOT-39.

THE NUCLEAR GAUGE MOISTURE READING SHALL NEVER BE USED FOR DETERMINATION OF IN PLACE DRY DENSITY.

H. Additional comparison checks against the oven dry method. These tests shall be performed at a minimum of at least once per 50 moisture tests. Results shall be documented on the DOT-39 worksheet and the correction factor reevaluated for the last five in place moisture comparison tests performed.

I. If a discrepancy exists, contact the Region Materials Engineer.

J. Record each standard count taken in the gauge's logbook.

3.6 Microwave Oven Moisture Test Method.

A. Determine the weight of a clean, dry container or dish, and record it on the applicable worksheet as "Wt. of Container".

B. Cut or break up the soil into small size aggregations to aid in obtaining quicker and more uniform drying of the specimen. Obtain a sample of wet material weighing a minimum of 100 grams for soils and a minimum of 500 grams for aggregates. Place the sample in the container, and immediately determine and record the weight to the nearest 0.1 gram.

C. Place the sample and container in a microwave oven and turn the oven on for 3 minutes. If experience with a particular soil type and specimen size indicates shorter or longer initial drying times can be used without overheating, the initial and subsequent drying times may be adjusted.

Note: The 3-minute initial setting is for a minimum sample size of 100 grams. Smaller samples are not recommended when using the microwave oven because drying may be too rapid for proper control. Large samples may need to be split into segments and dried separately.

Most ovens have a variable power setting. For the majority of soils tested, a setting of "high" should be satisfactory; however, for some soils such a setting may be too severe. The proper setting can be determined only through the use of and experience with a particular oven for various soil types and sample sizes. The energy output of microwave ovens may decrease with age and usage; therefore, power settings and drying times should be established for each oven.

D. After the set time has elapsed, remove the container and soil from the oven, weigh the specimen as soon as the container may be handled safely to the nearest 0.1 gram and record the weight.

E. With a small spatula, knife, or short length of glass rod, carefully mix the soil, taking special precaution not to lose any soil.

F. Return the container and soil to the oven and reheat for 1 minute.

G. Repeat (D) through (F), until a constant weight has been achieved as per SD 108.

H. Use the final weight to calculate the moisture content. Obtain this value immediately after the heating cycle, as soon as the container may be handled safely.

Note: Incremental heating, together with stirring, will minimize overheating and localized drying of the soil. The recommended time increments have been suitable for most specimens having particles smaller than a No. 4 sieve and with a sample of approximately 200 g; however, they may not be appropriate for all soils and ovens, and adjustment may be necessary.

Note: Moisture content specimens should be discarded after testing and not used in any other tests due to particle breakdown, chemical changes or losses, melting, or losses of organic constituents.

4. Report:

4.1 Calculations for Speedy Moisture Testers.

A. The dial on the moisture tester reads directly in percent moisture by wet weight. The reading must be converted to percent moisture by dry weight. The computation is made by using the conversion table which equates moisture contents by wet weight and dry weight in the normal range that will be encountered on grading projects, or by using the following formula:

$$\% \text{ Moisture by Dry Weight} = \frac{\% \text{ Moisture by Wet Weight}}{1 - (\% \text{ Moisture by Wet Weight divided by } 100)}$$

Example: % Moisture by Wet Weight is 14.8

$$\frac{14.8}{1 - (14.8 \text{ divided by } 100)} =$$

$$\frac{14.8}{1 - .148} = \frac{14.8}{.852} = 17.4\%$$

See Speedy Conversion Chart. (Figure 1.)

4.2 Calculations for Alcohol, Stove Top or Hot Plate, Oven Drying, and Microwave Oven Methods.

A. Calculate the percent of moisture for the alcohol, drying on a stove or hot plate, oven drying and microwave oven methods as follows:

Moisture Content =

$$\frac{\text{Weight wet soil} - \text{weight dry soil}}{\text{Weight dry soil}} \times 100$$

4.3 Calculations for the Nuclear Method – In-Place Moisture Test.

A. The percent moisture is read directly from the nuclear gauge.

A = Average of 5 oven dry moistures in percent, %.

B = Average of 5 nuclear gauge moisture in percent, %.

Calculate the moisture correction:

Compare "A" and "B".

If the absolute difference between "A" and "B" is 1.0% or less, it can be disregarded and no correction will be made on succeeding tests.

If "A" is 1.01% or greater than "B", the difference will be added to the nuclear gauge moisture content on succeeding tests.

If "B" is 1.01% or greater than "A", the difference will be subtracted from the nuclear gauge moisture content on succeeding tests.

5. References:

DOT-35
DOT-39
DOT-41
DOT-208
SD 114
SD 311
AASHTO T 310
AASHTO T 245

06

Speedy Reading	Percent Moisture Dry Weight	Speedy Reading	Percent Moisture Dry Weight	Speedy Reading	Percent Moisture Dry Weight	Speedy Reading	Percent Moisture Dry Weight	Speedy Reading	Percent Moisture Dry Weight	Speedy Reading	Percent Moisture Dry Weight
5.0	5.3	9.1	10.0	13.1	15.1	17.1	20.6	21.1	26.7	25.1	33.5
5.1	5.4	9.2	10.1	13.2	15.2	17.2	20.8	21.2	26.9	25.2	33.7
5.2	5.5	9.3	10.2	13.3	15.3	17.3	20.9	21.3	27.1	25.3	33.9
5.3	5.6	9.4	10.4	13.4	15.5	17.4	21.1	21.4	27.2	25.4	34.0
5.4	5.7	9.5	10.5	13.5	15.6	17.5	21.2	21.5	27.4	25.5	34.2
5.5	5.8	9.6	10.6	13.6	15.7	17.6	21.4	21.6	27.6	25.6	34.4
5.6	5.9	9.7	10.7	13.7	15.9	17.7	21.5	21.7	27.7	25.7	34.6
5.7	6.0	9.8	10.9	13.8	16.0	17.8	21.7	21.8	27.9	25.8	34.8
5.8	6.2	9.9	11.0	13.9	16.2	17.9	21.8	21.9	28.0	25.9	35.0
5.9	6.3	10.0	11.1	14.0	16.3	18.0	22.0	22.0	28.2	26.0	35.1
6.0	6.4	10.1	11.2	14.1	16.4	18.1	22.1	22.1	28.4	26.1	35.3
6.1	6.5	10.2	11.4	14.2	16.6	18.2	22.2	22.2	28.5	26.2	35.5
6.2	6.6	10.3	11.5	14.3	16.7	18.3	22.4	22.3	28.7	26.3	35.7
6.3	6.7	10.4	11.6	14.4	16.8	18.4	22.5	22.4	28.9	26.4	35.9
6.4	6.8	10.5	11.7	14.5	17.0	18.5	22.7	22.5	29.0	26.5	36.0
6.5	7.0	10.6	11.9	14.6	17.1	18.6	22.8	22.6	29.2	26.6	36.2
6.6	7.1	10.7	12.0	14.7	17.2	18.7	23.0	22.7	29.4	26.7	36.4
6.7	7.2	10.8	12.1	14.8	17.4	18.8	23.2	22.8	29.5	26.8	36.6
6.8	7.3	10.9	12.2	14.9	17.5	18.9	23.3	22.9	29.7	26.9	36.8
6.9	7.4	11.0	12.4	15.0	17.6	19.0	23.5	23.0	29.9	27.0	37.0
7.0	7.5	11.1	12.5	15.1	17.8	19.1	23.6	23.1	30.0	27.1	37.2
7.1	7.6	11.2	12.6	15.2	17.9	19.2	23.8	23.2	30.2	27.2	37.4
7.2	7.8	11.3	12.7	15.3	18.1	19.3	23.9	23.3	30.4	27.3	37.6
7.3	7.9	11.4	12.9	15.4	18.2	19.4	24.1	23.4	30.5	27.4	37.7
7.4	8.0	11.5	13.0	15.5	18.3	19.5	24.2	23.5	30.7	27.5	37.9
7.5	8.1	11.6	13.1	15.6	18.5	19.6	24.4	23.6	30.9	27.6	38.1
7.6	8.2	11.7	13.2	15.7	18.6	19.7	24.5	23.7	31.1	27.7	38.3
7.7	8.3	11.8	13.4	15.8	18.8	19.8	24.7	23.8	31.2	27.8	38.5
7.8	8.4	11.9	13.5	15.9	18.9	19.9	24.8	23.9	31.4	27.9	38.7
7.9	8.6	12.0	13.6	16.0	19.0	20.0	25.0	24.0	31.6	28.0	38.9
8.0	8.7	12.1	13.8	16.1	19.2	20.1	25.2	24.1	31.8	28.1	39.1
8.1	8.8	12.2	13.9	16.2	19.3	20.2	25.3	24.2	31.9	28.2	39.3
8.2	8.9	12.3	14.0	16.3	19.5	20.3	25.5	24.3	32.1	28.3	39.5
8.3	9.0	12.4	14.2	16.4	19.6	20.4	25.6	24.4	32.3	28.4	39.7
8.4	9.2	12.5	14.3	16.5	19.8	20.5	25.8	24.5	32.4	28.5	39.9
8.5	9.3	12.6	14.4	16.6	19.9	20.6	25.9	24.6	32.6	28.6	40.1
8.6	9.4	12.7	14.5	16.7	20.0	20.7	26.1	24.7	32.8	28.7	40.3
8.7	9.5	12.8	14.7	16.8	20.2	20.8	26.3	24.8	33.0	28.8	40.4
8.8	9.6	12.9	14.8	16.9	20.3	20.9	26.4	24.9	33.2	28.9	40.6
8.9	9.8	13.0	14.9	17.0	20.5	21.0	26.6	25.0	33.3	29.0	40.8
9.0	9.9										

Speedy Conversion Chart

Figure 1

Method of Sampling Gravel, Stone, Sand, Filler, and Clay

1. Scope:

These methods are for obtaining samples from pits, quarries, stockpiles, rail cars, conveyor belts, windrows, and trucks. Procedures for reducing field samples to testing size are described in SD 213.

Other methods giving representative samples may be used, if approved by the Chief Materials and Surfacing Engineer.

2. Apparatus:

2.1 Not Specified.

3. Procedure:

3.1 Pits.

A. Hole dug with auger.
Take material from the bottom of the auger representing each foot (300 mm) of depth as the hole is drilled. Sample approximately the same amount of material from each foot (300 mm) of depth. Take material from the auger only when it is going deeper and not just cleaning out the caved in material. Individual samples may be selected to represent material from each well-defined stratum.

B Exposed Faces.
Take the sample by channeling the exposed face vertically from bottom to top. Overburden and disturbed material shall not be included in the sample. Individual samples may be selected to represent material from each well-defined stratum.

3.2 Conveyor Belt.

A. Stop the conveyor belt while obtaining the sample. Insert 2 templates conforming to the width and shape of the belt into the aggregate stream on the belt. Scoop all material between the templates into a suitable container using a brush to collect the fines on the belt.

If templates are not available, care must be taken to prevent material from the upper side of the belt from sliding or rolling onto the section being sampled.

Sample the full width of the belt.

B. A special device capable of obtaining an entire cross section of the material as it is being discharged from the belt may be used. This device must consist of a pan of sufficient size to intercept the entire cross section of the discharge stream and hold the required quantity of material without overflowing. A set of rails or another suitable device must be included so that a representative sample of the entire stream can be obtained. Obtain at least three approximately equal increments and combine to form the field sample.

3.3 Windrows.

Sample the material in windrows by shoveling through small windrows or removing material to the midpoint of the cross section of large windrows. Waste the material removed in both procedures. Shave material from one face of the cross sectional area for the sample.

3.4 Stockpile.

A. Cone Shaped Stockpile.

Take material from the base, midpoint, and top of the pile. Shove a board into the pile above the point of sampling to reduce segregation.

B. Flat Topped Stockpile.

Dig three or more shallow trenches on top of the stockpile approximately 10 feet (3 m) long and 1 foot (300 mm) wide. The bottom of the trenches shall be nearly level. Take equal portions from 3 equally spaced points along the bottom of each trench by pushing a shovel downward into the material and taking a shovel full from each point.

3.5 Rail cars and trucks.

Dig 3 or more shallow trenches the full width of the rail car or truck with the bottom of the trench nearly level and approximately one foot (300 mm) wide. Take equal portions from 3 equally spaced points along the bottom

of each trench by pushing a shovel downward into the material and taking a shovel full from each point.

3.5 Quarries.

See AASHTO T 2.

4. Report:

None required.

5. References:

AASHTO T 2
SD 213

Method of Test for Sieve Analysis

1. Scope:

This test is for determining sieve analysis of sub-base, base course, mineral aggregate (surface course materials), concrete aggregates, fillers, and similar materials.

2. Apparatus:

2.1 Scale or Balance having the capacity to weigh any sample which may be tested utilizing this procedure and readable to the nearest 0.1 gram.

2.2 Sieves. Standard square opening, conforming to AASHTO M 92.

2.3 Drying oven capable of maintaining a temperature of 230° ±9°F (110° ±5°C).

2.4 Pans, scoops, brushes, etc., for handling materials.

2.5 Unit weight bucket.

2.6 Mechanical sieve shaker.

3. Procedure:
Surface Course Materials:

3.1 Obtain a sample in accordance with SD 201. The sample shall be large enough to provide four specimens for testing.

3.2 Reduce the sample to the size of the specimen needed for testing by splitting or quartering in accordance with SD 213.

3.3 Minimum sample size (Note: Nominal maximum size of particle is denoted by the smallest sieve opening listed below, through which 90% or more of the sample being tested will pass).

Nominal Maximum Size of Particle	Minimum Wt. of Sample Grams
#4 (4.75 mm)	500
3/8" (9.5 mm)	1000
1/2" (12.5 mm)	2500
3/4" (19.0 mm)	5000
1" (25.0 mm)	10000
1 1/2" (37.5 mm)	15000
2" (50.0 mm)	20000
2 1/2" (63.0 mm)	35000
3" (75.0 mm)	60000
3 1/2" (90.0 mm)	100000
4" (100 mm)	150000

3.4 The sample shall be oven dried to a constant weight at a temperature of 230° ±9°F (110° ±5°C) or in accordance with SD 108. Frequent stirring will expedite the drying procedure.

3.5 Determine Loose weight, if required, in accordance with SD 204.

3.6 Weigh the sample and record the weight in the "original dry sample weight" box of the worksheet to the nearest 0.1 gram.

3.7 Assemble a series of sieves that will furnish the information required by the specifications covering the material to be tested. Nest the sieves in order of decreasing size of opening from top to bottom and include a pan below the last sieve.

3.8 Pour the sample into the top sieve of the nest. Agitate the sieves by hand or on a mechanical shaker for a sufficient period of time, established by trial or checked by measurement on the actual test sample, to meet the criterion for adequacy of sieving.

Note: The adequacy of sieving can be checked by the hand method. The end point for hand sieving requires that not more than 0.5% by weight of the material on a sieve shall pass that sieve in one minute of sieving.

3.9 Remove any dirt adhering to the plus #4 (4.75 mm) material. This can be accomplished by dumping the material from each individual sieve into a flat pan and rubbing it with a soft pine or rubber covered block. After the dirt has been removed, pour the contents of the pan back onto the sieves and complete the shaking.

An alternate method is to place the material retained on an individual sieve in a cement sample can. With the lid in place, agitate the

aggregate using a circular motion. The material is then reintroduced to the sieve and sieved by hand.

3.10 Weigh the material retained on each sieve and the material in the pan to the nearest 0.1 gram and record the weights on the worksheet. Tabulate the total for these weights. The tabulated total should check within 0.3% of the "original dry sample weight." If it does not, a backup sample shall be tested.

3.11 In the coarse sieve series, the weight retained on a sieve in kg at the completion of sieving shall not exceed the product of 2.5 times the sieve size opening in millimeters times the effective sieving area in m^2 (see table below). Sieve to a point of refusal or approximately 10 minutes if using a large mechanical sieve shaker.

Sieve Opening Size Inches/mm	Maximum Amount of Material that may be retained			
	8" Dia. Sieve	12" Dia Sieve	13.8" x 13.8" Sieve (14"x14" Nominal)	14.6" x 22.8" Sieve (16"x24" Nominal)
4" (100.0 mm)		NA	30,600 grams	53,900 grams
3 1/2" (90.0 mm)		15,100 grams	27,600 grams	48,500 grams
3" (75.0 mm)		12,600 grams	23,000 grams	40,500 grams
2 1/2" (63.0 mm)		10,600 grams	19,300 grams	34,000 grams
2" (50.0 mm)	3,560 grams	8,400 grams	15,300 grams	27,000 grams
1 1/2" (37.5 mm)	2,670 grams	6,300 grams	11,500 grams	20,200 grams
1" (25.0 mm)	1,780 grams	4,200 grams	7,700 grams	13,500 grams
3/4" (19.0 mm)	1,350 grams	3,200 grams	5,800 grams	10,200 grams
5/8" (16.0 mm)	1,140 grams	2,650 grams	4,800 grams	8,450 grams
1/2" (12.5 mm)	890 grams	2,100 grams	3,800 grams	6,700 grams
3/8" (9.5 mm)	670 grams	1,600 grams	2,900 grams	5,100 grams
1/4" (6.3 mm)	450 grams	1,200 grams	2,200 grams	3,850 grams
#4 (4.75 mm)	330 grams	800 grams	1,500 grams	2,600 grams
#8 thru #200 (2.36 mm thru 75 µm)	200 grams	400 grams	NA	NA

06

Chart 1

3.12 Calculate the percentage of material retained on each sieve to the nearest 0.1% by dividing the weight of the retained material by the "original dry sample weight" determined in 3.6.

3.13 Determine the accumulative percent passing each sieve by subtracting the retained percentage for the top sieve from 100.0 and continue subtracting the retained percentage for each sieve from the previous sieves accumulative passing percentage.

3.14 If the sample being tested requires a result for Percentage of Crushed Pieces, perform the test in accordance with SD 211 using a portion of the aggregate retained on the #4 (4.75 mm) sieve and above.

Note: If the material being tested requires a result for Total -#200, the material from that test can be used to perform the Percentage of Crushed Pieces test.

3.15 If the sample being tested requires a result for Percentage of Particles Less Than 1.95 Specific Gravity for the plus #4 (4.75 mm) sieve material, perform the test in accordance with SD 214 using a portion of the aggregate retained on the #4 (4.75 mm) sieve and above.

3.16 Using the material from the pan below the #4 (4.75 mm) sieve, split out samples in accordance with SD 213 to conduct the balance of the required testing. The number and size of samples to be split out will depend on the type of material being tested. Most (surface course materials) will require a sample to complete the fine portion of the sieve analysis and one for Liquid Limit/Plastic Limit/P.I. If you are testing Uncoated Mineral Aggregate for Asphalt Concrete, a third sample will have to be split out for a Particles Less Than 1.95 Specific Gravity test.

The samples split out for the fine portion of the Sieve Analysis and Liquid Limit/Plastic Limit/P.I. must contain a minimum of 500 grams while the sample for the Less Than 1.95 Specific Gravity test must contain somewhere between 250 and 350 grams.

3.17 Weigh the sample to be used for the fine portion of the Sieve Analysis to the nearest 0.1 gram and record the weight on the "weight before washing" line on the worksheet.

3.18 Place the sample in a pan and add enough water to cover it. Agitate the sample with sufficient vigor to result in complete separation of all particles finer than the #200 (0.075 mm) sieve from the coarser particles and bring the fine material into suspension. Pour the wash water containing the suspended and dissolved solids over a nest of 2 sieves. The lower sieve of the nest shall be a #200 (0.075 mm) and the upper shall be in a range of #8 (2.36 mm) to #16 (1.18 mm). Both of the sieves shall conform to the requirements of AASHTO M 92. Repeat the process of adding water, agitating the sample, and pouring the water over the nest of sieves until the wash water is clear.

3.19 Dry the washed aggregate to a constant weight in an oven at 230° ±9°F (110° ±5°C), as per SD 108 and weigh to the nearest 0.1 gram. Record this weight on the "weight after washing" line of the worksheet.

Subtract the weight of the sample after washing, from the weight of the sample before washing and record the result on the "loss from washing (- #200)" line and on the "PAN wash" line below the #200 (0.075 mm) sieve on the sieve analysis.

3.20 Assemble a series of sieves that will furnish the information required by the specifications covering the material being tested. Nest the sieves in order of decreasing size of opening from top to bottom and include a pan below the last sieve.

3.21 Pour the aggregate into the top sieve of the nest, place the nest of sieves on a mechanical shaker and shake for a sufficient period of time (a minimum of 10 minutes). Adequacy of sieving can be checked as outlined in 3.8 above. The quantity of material retained on any sieve at the completion of the sieving operation shall not exceed 4 grams per in^2 (6 kg/m^2) of sieve surface area. This amounts to 200 grams for an 8" (200 mm) diameter sieve.

3.22 Weigh the material retained on each sieve and in the pan and record the weights on the worksheet to the nearest 0.1 gram. Add the retained weights including the PAN dry and PAN wash quantities below the #200 (0.075 mm) sieve. Record this weight on the "TOTAL" line at the bottom of the worksheet. This weight must be within 0.3% of the weight of the sample before washing. If it is not, a new sample shall be tested.

NOTE: Correct brush to use when cleaning sieves.

3/8" - #16 - steel
#20 - #50 - brass
#80 - > - paint

3.23 Complete the calculations for the fine sieves, beginning by dividing the initial sample weight derived in 3.17 above into the retained weights for each sieve and record the results on the worksheet to the nearest 0.1%. Next, multiply these retained percentages times the Accumulative Percentage passing the #4 (4.75 mm) sieve determined in 3.13 above and record the results on the worksheet again to the nearest 0.1%. Finally, determine the accumulative percentage passing each of these sieves by subtracting the retained percentage from the previous sieves accumulative passing percentage.

3.24 The percentage of material passing each sieve in the coarse and fines portion of the analysis may now be rounded and reported on the worksheet to the nearest whole number except the #200 (0.075 mm) sieve shall be reported to the nearest 0.1%.

3.25 Prepare the sample of material split out earlier as outlined in SD 207 (3.1 to 3.4) for Liquid Limit/Plastic Limit/P.I. testing.

3.26 Perform the Liquid Limit and Plastic Limit in accordance with SD 207, calculate the plasticity index, and report the results on the sieve analysis worksheet.

3.27 If the sample being tested requires a result for Percentage of Particles Less Than 1.95 Specific Gravity for the minus #4 (4.75 mm) sieve material, perform the test on the 250 to 350 gram sample split out in 3.16 above in accordance with SD 208.

Process for Determining Total -#200 Materials in Asphalt Concrete:

3.28 Following completion of the coarse Sieve Analysis, combine all materials which were retained on #4 sieve and above and split out a sample for Total -#200 (0.075 mm) testing in accordance with SD 213 which meets the requirements shown in the following table.

Nominal Maximum Size of Particles		Minimum Weight of Sample, Grams
#4	(4.75 mm)	500
3/8"	(9.50 mm)	500
1/2"	(12.5 mm)	650
3/4"	(19.0 mm)	1000
1"	(25.0 mm)	1500

3.29 Weigh the sample to the nearest 0.1 g and record the weight as "weight before washing" in the box (labeled A) below the coarse sieve area as shown on the enclosed example DOT-3 worksheet.

3.30 Place the sample in a pan and add enough water to cover it. Agitate the sample with sufficient vigor to result in complete separation of all particles finer than the #200 (0.075 mm) sieve from the coarser particles and bring the fine material into suspension. Pour the wash water containing the suspended and dissolved solids over a nest of 2 sieves. The lower sieve of the nest shall be a #200 (0.075 mm) and the upper shall be in a range of #8 (2.36 mm) to #16 (1.18 mm). Both of the sieves shall conform to the requirements of AASHTO M 92. Repeat the process of adding water, agitating the sample, and pouring the water over the nest of sieves until the wash water is clear.

3.31 Following drying to a constant weight, weigh sample to nearest 0.1 g and record the weight as "weight after wash" in the box (labeled B) below the Coarse Sieve area as shown on the enclosed example DOT-3 worksheet.

3.32 Calculate the percent passing the #200 Sieve (D) for the coarse aggregate by subtracting the "weight after wash" (B) from the "weight before wash" (A) and dividing that result (C) by the "weight before

wash" (A). Multiply this result times 100. This is the percent minus #200 for the Coarse Aggregate which must be recorded in the two boxes (labeled D on the DOT-3 Worksheet).

6.3 1/4		354.6	7.0	67.9	68	
4.75 #4	*	345.4	6.8 (F)	61.1	61	57-67
PAN		3090.1	61.1	wt. before washing(0.1 g)	(A)	1069.3
TOTAL		5055.10	100.0	wt. after washing (0.1 g)	(B)	1058.5
+ #4 Gradation Check				loss from washing	(C)	10.8
within 0.3% of the orginal dry wt.			0.1%	% - #200	(D)	1.01

3.33 To complete the calculations for the total minus #200 material, four pieces of information are needed in the minus #200 box at the lower left corner of the DOT-3 Worksheet. You have already provided one of these in step 3.32 above, ((D) which is the percent passing the #200 Sieve on the Coarse Aggregate sample wash). The other three are: (E) The percent passing the #200 Sieve on the fine Sieve Analysis (this includes the washed and sieved portion), (F) The percentage of material that passed the #4 Sieve during the sieve analysis and (G) the percentage of material that was retained on the #4 Sieve. The amount of material retained on the #4 Sieve (G) can be determined by subtracting the percent passing the #4 sieve (F) from 100.

3.34 Complete the calculations by Multiplying the percent minus #200 on the Coarse Sieve Aggregate (D) times the percent of material retained on the #4 Sieve (G) and Multiply the percent minus #200 on the Fine Sieves (E) times the percent of material that passed the #4 Sieve (F) and divide each by 100. The result obtained when adding these 2 values is the "Total minus #200 Material" for this sample.

Example: The Coarse Sieve Analysis had 61.1% Passing the #4 Sieve. 100.0 minus 61.1% Passing = 38.9% Retained on the #4 Sieve.

1.01% passed the #200 Sieve in the Coarse Aggregate sample that was washed (D) and 10.06% passed the #200 Sieve on the Fine Sieve Analysis (E).

0.075 200		90.4	17.3	10.6	6.1	6.1
PAN dry		2.5	52.5	6.15	wt. before washing(0.1 g)	
PAN wash		50.0	(E) 10.06		wt. after washing (0.1 g)	
TOTAL	*	521.5			loss from washing (- #200)	
Coarse	(D) 1.01	x % Retain/Des	(G) 38.9	0.39	- #4 Gradation check	
Fine	(E) 10.06	x % Pass/Desig	(F) 61.1	6.15	within 0.3 % of the	
		Total/Combined - #200		6.5		
Na.Rock 17% Jones			Natural Fines 45% Jones		Cr.Fines	

Calculations:

Retained #4 Sieve $\frac{(G)\ 38.9\% \times (D)\ 1.01\%\ \text{Pass on Coarse Aggr.}}{100} = 0.39\%$

Passing #4 Sieve $\frac{(F)\ 61.1\% \times (E) 10.06\%\ \text{Pass on Fine Analysis}}{100} = 6.15\%$

0.39 + 6.15 = 6.54 or 6.5% Total minus #200 for the sample

Coarse Aggregate for Concrete:

3.35 Obtain a sample in accordance with SD 201. The sample shall be large enough to provide four complete specimens for testing.

3.36 Reduce the sample to the size of the various specimens needed for testing by splitting or quartering in accordance with SD 213. The number of specimens needed will depend on the testing required for the sample.

Most samples will require, as a minimum, a Sieve Analysis, Material Finer Than #200 (0.075 mm) Sieve and Particles Less Than 1.95 Specific Gravity in Coarse Aggregate. Scratch Hardness will be required when natural coarse aggregate is used.

3.37 For the minimum size of samples for the various tests required, see 3.3 above for the Sieve Analysis, SD 206 for Material Finer Than #200 (0.075 mm) Sieve, SD 214 for Particles Less Than 1.95 Specific Gravity in Coarse Aggregate and SD 218 for Scratch Hardness.

Lightweight Coarse Aggregate specimens shall consist of 0.1 ft^3 (0.003 m^3) or more of the material.

3.38 Perform the Sieve Analysis following the procedure outlined in 3.4, 3.6, 3.7, 3.8, 3.10, 3.11, 3.12, and 3.13 above. Coarse aggregate for concrete has a specification on the #8 (2.36 mm) sieve, so it will be necessary to add that sieve to the nest of sieves.

3.39 Using the samples split out in 3.36 above, perform the test for Material Finer Than #200 (0.075 mm) Sieve in accordance with SD 206, Particles Less Than 1.95 Specific Gravity in Coarse Aggregate in accordance with SD 214 and Scratch Hardness of natural coarse aggregate in accordance with SD 218. Report the results of these tests on the worksheet in accordance with the guidelines provided by the applicable test procedure.

Fine Aggregate for Concrete:

3.40 Obtain a sample in accordance with SD 201. The sample shall be large enough to provide four complete specimens for testing.

3.41 If the sample has free moisture on the particle surface, the entire sample may be dried or it may be split using a mechanical splitter with chute openings of 1 1/2" (38 mm) or more, to not less than 11 lbs. (5000 grams) and then dried.

3.42 Reduce the dried sample to the size of the various specimens needed for testing by splitting or quartering in accordance with SD 213. The number of specimens needed will depend on the testing required for the sample.

NOTE: If the sample received from the field does not have free moisture on the particle surface, it may be reduced to the various testing specimens by splitting or quartering in accordance with SD 213. It will, however, require drying before testing may begin.

Most samples will require, as a minimum, a Sieve Analysis, inclusive of Material Finer Than #200 (0.075 mm) Sieve, and Particles Less Than 1.95 Specific Gravity in Fine Aggregate.

The sample split out for the Sieve Analysis, inclusive of Material Finer Than #200 (0.075 mm) Sieve, must contain a minimum of 500 grams while the sample for the Less Than 1.95 Specific Gravity in Fine Aggregate test must contain between 250 and 350 grams.

The minimum sample specimen weight for the Sieve Analysis, inclusive of Material Finer Than #200 (0.075 mm) Sieve, for Lightweight Fine Aggregate shall be as shown below:

Specimen	Wt. of Aggregate ($lbs./ft^3$)	Wt. of Aggregate (kg/m^3)	Minimum Wt. of Test in Grams
	5 to 15	80 to 240	50
	15 to 25	240 to 400	100
	25 to 35	400 to 560	150
	35 to 45	560 to 720	200
	45 to 55	720 to 880	250
	55 to 65	880 to 1040	300
	65 to 75	1040 to 1200	350

3.43 Perform the Sieve Analysis, inclusive of Material Finer Than #200 (0.075 mm) Sieve, in accordance with procedure outlined in 3.17, 3.18, 3.19, 3.20, 3.21, and 3.22 above.

Fine aggregate for concrete has a specification on the 3/8" (9.5 mm) and #4 (4.75 mm) sieve, so it will be necessary to add these sieves to the nest of sieves.

3.44 Calculate the percentage of material retained on each sieve to the nearest 0.1% by dividing the weight of the retained material by the weight of the sample before washing. Material passing #200 should be calculated to 0.01% and rounded to 0.1%.

3.45 Determine the accumulative percent passing each sieve by subtracting the retained percentage for the top sieve from 100.0 and continue subtracting the retained percentage for each sieve from the previous sieves accumulative passing percentage.

3.46 The percentage of material passing each sieve may now be rounded and reported on the worksheet to the nearest whole number except the #200 (0.075 mm) sieve shall be reported to the nearest 0.1%.

3.47 Samples of fine aggregate for concrete require a result for Fineness Modulus (F.M.). The sieves used for determination of F.M. are identified on the DOT-3 worksheet by an (*). Calculate the F.M. as follows:

A. Subtract the percentage passing (before rounding) the sieves designated by the (*) from 100.0 and record the result in the column titled F.M. After this has been accomplished on each sieve designated, total the results and divide by 100.

B. Report the result to the nearest 0.01%.

EXAMPLE:

Sieve Size	Percent Passing	100.0 Minus Percent Passing
#4 (4.75 mm)	98.1	1.9
#8 (2.36 mm)	89.8	10.2
#16 (1.18 mm)	70.4	29.6
#30 (0.600 mm)	38.9	61.1
#50 (0.300 mm)	22.6	77.4
#100 (0.150 mm)	9.3	90.7
	Total	270.9

$$\text{Fineness Modulus} = \frac{270.9}{100} = 2.709 \text{ or } 2.71$$

3.48 The specifications for aggregates used in concrete require the combined mixture of fine and coarse aggregate be such that not more than a certain percent of the combined materials pass the #200 (0.075 mm) sieve.

To calculate this combined percentage of material passing the #200 (0.075 mm) sieve, multiply the percent passing the #200 (0.075 mm) sieve on the fine and coarse aggregate times the percentage of the sand and rock used in the mix according to the design mix, divide each of the results by 100 and then add them together.

EXAMPLE:

A. .88% passing #200 (0.075 mm) sieve on fine aggregate.
B. 1.65% passing #200 (0.075 mm) sieve on coarse aggregate.
C. Fine Aggregate is 35.6% of total aggregate used in the mix.
D. Coarse Aggregate is 64.4% of total aggregate used in the mix.

Fine Aggregate .88% x 35.6% / 100 = 0.31%
Coarse Aggregate 1.65% x 64.4% / 100 = 1.06%
Combined minus #200 (0.075 mm) sieve = 1.37 or 1.4%.

The final percentage shall be recorded to the nearest 0.1%

3.49 Perform the test for Particles Less Than 1.95 Specific Gravity in Fine Aggregates in accordance with SD 208 and report the results on the worksheet.

4. Report:

4.1 Test results will be reported on form DOT-3 or DOT-68 (these forms do not apply to the Central Lab). Use of the DOT-68 is limited to mineral aggregate samples on projects utilizing a batch type mixing plant.

5. References:

AASHTO T 27
AASHTO M 92
SD 108
SD 201
SD 204
SD 206
SD 207
SD 208
SD 211
SD 213

SD 214
DOT-3
DOT-68

SCREEN ANALYSIS AND P.I. WORKSHEET

DOT - 3
9-02

FILE NUMBER 15.4

COUNTY Armstrong | PROJECT F 0037(4)196 | PCN 8836
SAMPLE NO. 6 | DATE SAMPLED 8/8/1999 | DATE TESTED 8/8/1999
SAMPLED BY J. Smith | TESTED BY J. Smith | CHECKED BY CS
MATERIAL TYPE Asph. Conc. Class E Type 1 | SOURCE R. Jones Pit

WEIGHT TICKET NUMBER OR STATION 76421 | LIFT Final

% moist. = (wet wt. 5235.10 - dry wt.) / dry wt. x 100 = 3.5%
ORIGINAL DRY SAMPLE WT. (0.1g) 5058.2

sieve size mm	sieve size in	F.M. *	Retained (.01 lb / 0.1g)	% total ret. (0.1%)	Acc.% pass. (0.1%)	Acc.% pass. (rounded)	SPEC REQ.
50.0	2						
37.5	1 1/2						
31.5	1 1/4						
25.0	1				100.0	100	**100**
19.0	3/4		30.3	0.6	99.4	99	**97-100**
16.0	5/8		159.7	3.2	96.2	96	
12.5	1/2		620.1	12.3	83.9	84	**76-90**
9.5	3/8	*	454.9	9.0	74.9	75	
6.3	1/4		354.6	7.0	67.9	68	
4.75	#4	*	345.4	6.8	(F) 61.1	61	**57-67**
PAN			3090.1	61.1	wt. before washing(0.1 g)	(A)	1069.3
TOTAL			5055.1	100.0	wt. after washing (0.1 g)	(B)	1058.5
					loss from washing	(C)	10.8
					% - #200	(D)	1.01

+ #4 Gradation Check
within 0.3% of the orginal dry wt. 0.1%

L. L., P. L., and P. I.

		L.L.	P.L.
a. can number		24	25
b. wt. can + wet soil	(.01 g)	40.47	31.42
c. wt. can + dry soil	(.01 g)	36.79	29.50
d. wt. of water (b - c)	(.01 g)	3.68	1.92
e. wt. of can	(.01 g)	18.47	18.63
f. wt. of dry soil (c - e)	(.01 g)	18.32	10.87
g. Liquid Limit(d/f x j x 100)	(0.1)	20.1	N.A.
h. Plastic Limit (d/f x 100)	(0.1)	N.A.	17.7
i. P. I. (g - h)	(0.1)	2.4	
Liquid Limit (g. rounded)		20	N.A.
Plasticity Index (i. rounded)		**2**	

j. corr. # blows 25 22 = 0.9846, 23 = 0.9899, 24 0.9952
25 = 1.0000, 26 = 1.0050, 27 = 1.0100, 28 = 1.0138

wt. - #40 111.5 ÷ wt. - #4 321.6 x % pass.#4 21.2%
(± 3.0% VARIABLE of Acc. % pass. (0.1%) on the #40)

SPECIFICATION L.L. max. 25
SPECIFICATION P.I. max. 3

sieve size mm	sieve size #		Retained (0.1g)	% total ret.(0.1%)	% total x % pa.#4(0.1%)	Acc.% pass. (0.1%)	Acc.% pass. (rounded)	REQ.
2.36	8	*	104.1	20.0	12.2	48.9	49	**42-52**
2.00	10							
1.18	16	*	83.4	16.0	9.8	39.1	39	**32-42**
0.850	20							
0.600	30	*	113.3	21.7	13.3	25.8	26	
0.425	40		33.2	6.4	3.9	21.9	22	**14-24**
0.300	50	*						
0.180	80		44.6	8.5	5.2	16.7	17	
0.150	100	*						
0.075	200		90.4	17.3	10.6	6.1	6.1	**4.0-8.0**
PAN	dry		2.5	52.5	6.15	wt. before washing(0.1 g)		521.8
PAN	wash		50.0	(E) 10.06		wt. after washing (0.1 g)		471.8
TOTAL		*	521.5			loss from washing (- #200)		50.0

+ #4 % PARTICLES LESS THAN 1.95 SP.GR.

Specific gravity of solution (1.95 ± 0.01)		1.96
wt. of lightweight particles	(0.1 g)	30.3
weight of + #4 material	(0.1 g)	1921.4
% lightweight particles		1.6%
SPECIFICATION maximum		2.0%

- #4 % PARTICLES LESS THAN 1.95 SP.GR.

Specific gravity of solution (1.95 ± 0.01)		1.96
wt. of lightweight particles	(0.1 g)	5.2
weight of - #4 material	(0.1 g)	304.1
% lightweight particles		1.7%
SPECIFICATION maximum		2.0%

Coarse (D) 1.01 x % Retain/Des (G) 38.9 0.39
Fine (E) 10.06 x % Pass/Desig (F) 61.1 6.15
Total/Combined - #200 6.5

- #4 Gradation check
within 0.3 % of the 0.1%

CRUSHED PARTICLES TEST

weight of crushed pieces	(0.1 g)	786.4
weight of total + #4 sample	(0.1 g)	1008.9
percent of crushed pieces	(%Whole)	78%
SPECIFICATION 2 or more FF, min.		50%

Na.Rock 17% Jones | Natural Fines 45% Jones | Cr.Fines 23%
Cr.Rock | Natural Sand | Ma.Sand
Filler | Spencer Add Rock 15%

COMMENTS:

Figure 1

SCREEN ANALYSIS AND P.I. WORKSHEET

FILE NUMBER _____

DOT - 3
9-02

COUNTY Jones | PROJECT NH 0083(12)19 | PCN 3275
SAMPLE NO. 2 | DATE SAMPLED 10/21/1999 | DATE TESTED 10/22/1999
SAMPLED BY J. Brown | TESTED BY G. Stuchl | CHECKED BY BH
MATERIAL TYPE Coarse Aggregate Size 1 A-45 (Paving) | SOURCE Spencer Quarry
WEIGHT TICKET NUMBER OR STATION Belt, Ticket # 12593 | LIFT

% moist. = (wet wt. _____ - dry wt.) / dry wt. x 100 = _____

ORIGINAL DRY SAMPLE WT. (0.1g) 10414.8

sieve size mm	sieve size in	F.M. *	Retained (.01 lb / 0.1g)	% total ret. (0.1%)	Acc.% pass. (0.1%)	Acc.% pass. (rounded)	SPEC REQ.
50.0	2						
37.5	1 1/2						
31.5	1 1/4		0.0		100.0	100	
25.0	1		286.0	2.7	97.3	97	95-100
19.0	3/4		1720.7	16.5	80.8	81	
16.0	5/8		1098.7	10.5	70.3	70	
12.5	1/2		1407.4	13.5	56.8	57	25-60
9.5	3/8	*	1620.8	15.6	41.2	41	
6.3	1/4		2492.5	23.9	17.3	17	
4.75	#4	*	908.0	8.7	8.6	9	0-10
PAN					wt. before washing(0.1 g)		
TOTAL				100.0	wt. after washing (0.1 g)		
+ #4 Gradation Check within 0.3% of the orginal dry wt.				0.2%	loss from washing %-#200		

L. L., P. L., and P. I.

		L.L.	P.L.
a. can number			
b. wt. can + wet soil	(.01 g)		
c. wt. can + dry soil	(.01 g)		
d. wt. of water (b - c)	(.01 g)		
e. wt. of can	(.01 g)		
f. wt. of dry soil (c - e)	(.01 g)		
g. Liquid Limit(d/f x j x 100)	(0.1)		N.A.
h. Plastic Limit (d/f x 100)	(0.1)	N.A.	
i. P. I. (g - h)	(0.1)		
Liquid Limit (g. rounded)			N.A.
Plasticity Index (i. rounded)			

j. corr. # blows _____ 22 = 0.9846, 23 = 0.9899, 24 0.9952 25 = 1.0000, 26 = 1.0050, 27 = 1.0100, 28 = 1.0138

wt. - #40 _____ ÷ wt. - #4 _____ x % pass.#4 = _____
(± 3.0% VARIABLE of Acc. % pass. (0.1%) on the #40)

SPECIFICATION L.L. max. _____
SPECIFICATION P.I. max. _____

sieve size mm	sieve size #		Retained (0.1g)	% total ret.(0.1%)	% total x % pa.#4(0.1%)	Acc.% pass. (0.1%)	Acc.% pass. (rounded)	REQ.
2.36	8	*	644.7	6.2		2.4	2	0-5
2.00	10							
1.18	16	*						
0.850	20							
0.600	30	*						
0.425	40							
0.300	50	*						
0.180	80							
0.150	100	*						
0.075	200							
PAN	dry		217.9	2.1	0.0	wt. before washing(0.1 g)		5506.6
PAN	wash			0.00		wt. after washing (0.1 g)		5415.0
TOTAL		*	10396.7			loss from washing (- #200)		91.0

+ #4 % PARTICLES LESS THAN 1.95 SP.GR.

Specific gravity of solution (1.95 ± 0.01)		1.96
wt. of lightweight particles	(0.1 g)	15.0
weight of + #4 material	(0.1 g)	1857.0
% lightweight particles		0.8%
SPECIFICATION maximum		1.0%

- #4 % PARTICLES LESS THAN 1.95 SP.GR.

Specific gravity of solution (1.95 ± 0.01)		
wt. of lightweight particles	(0.1 g)	
weight of - #4 material	(0.1 g)	
% lightweight particles		
SPECIFICATION maximum		

Coarse	1.65	x % Retain/Desigr	64.4	1.06
Fine	0.88	x % Pass/Design	35.6	0.31
		Total/Combined - #200		1.4%

- #4 Gradation check within 0.3 % of the _____

Na.Rock _____ Natural Fines _____ Cr.Fines _____
Cr.Rock _____ Natural Sand _____ Ma.Sand _____
Filler _____ Spencer Add Rock _____

CRUSHED PARTICLES TEST

weight of crushed pieces	(0.1 g)	
weight of total + #4 sample	(0.1 g)	
percent of crushed pieces	(%Whole)	
SPECIFICATION 2 or more FF, min.		

COMMENTS: _____

Figure 2

SCREEN ANALYSIS AND P.I. WORKSHEET

DOT - 3
9-02

FILE NUMBER _____

COUNTY Jones | PROJECT NH 0083(12)19 | PCN 3275
SAMPLE NO. 2 | DATE SAMPLED 10/21/1999 | DATE TESTED 10/22/1999
SAMPLED BY J. Brown | TESTED BY G. Stuchl | CHECKED BY BH
MATERIAL TYPE Fine Aggregate | SOURCE Spencer Quarry
A-45 (Paving)
WEIGHT TICKET NUMBER OR STATION Belt, Ticket # 12593 | LIFT _____

% moist. = (wet wt. _____ - dry wt.) / dry wt. x 100 = _____

ORIGINAL DRY SAMPLE WT. (0.1g) _____

sieve size mm	sieve size in	F.M. *	Retained (.01 lb / 0.1g)	% total ret. (0.1%)	Acc.% pass. (0.1%)	Acc.% pass. (rounded)	SPEC REQ.
50.0	2						
37.5	1 1/2						
31.5	1 1/4						
25.0	1						
19.0	3/4						
16.0	5/8						
12.5	1/2						
9.5	3/8	*	0.0	0.0	100.0	100	100
6.3	1/4						
4.75	#4	* 0.2	1.1	0.2	99.8	100	95-100
PAN							
TOTAL							

wt. before washing (0.1 g) _____
wt. after washing (0.1 g) _____
loss from washing _____
% - #200 _____

+ #4 Gradation Check
within 0.3% of the orginal dry wt. _____

L. L., P. L., and P. I.

		L.L.	P.L.
a. can number			
b. wt. can + wet soil	(.01 g)		
c. wt. can + dry soil	(.01 g)		
d. wt. of water (b - c)	(.01 g)		
e. wt. of can	(.01 g)		
f. wt. of dry soil (c - e)	(.01 g)		
g. Liquid Limit(d/f x j x 100)	(0.1)		N.A.
h. Plastic Limit (d/f x 100)	(0.1)	N.A.	
i. P. I. (g - h)	(0.1)		
Liquid Limit (g. rounded)			N.A.
Plasticity Index (i. rounded)			

j. corr. # blows _____ 22 = 0.9846, 23 = 0.9899, 24 0.9952
25 = 1.0000, 26 = 1.0050, 27 = 1.0100, 28 = 1.0138

wt. - #40 _____ ÷ wt. - #4 _____ x % pass.#4 = _____
(± 3.0% VARIABLE of Acc. % pass. (0.1%) on the #40)

SPECIFICATION L.L. max. _____
SPECIFICATION P.I. max. _____

sieve size mm	#		Retained (0.1g)	% total ret.(0.1%)	% total x % pa.#4(0.1%)	Acc.% pass. (0.1%)	Acc.% pass. (rounded)	REQ.
2.36	8	* 16.1	90.9	15.9		83.9	84	
2.00	10							
1.18	16	* 44.4	161.2	28.3		55.6	56	45-85
0.850	20							
0.600	30	* 67.7	132.8	23.3		32.3	32	
0.425	40							
0.300	50	* 88.5	118.3	20.8		11.5	12	10-30
0.180	80							
0.150	100	* 97.7	52.7	9.2		2.3	2	2-10
0.075	200		9.0	1.6		0.7	0.7	
PAN	dry		0.9	5.0		wt. before washing(0.1 g)		570.0
PAN	wash		4.1	0.88		wt. after washing (0.1 g)		565.9
TOTAL		* 3.15	571.0			loss from washing (- #200)		4.1

+ #4 % PARTICLES LESS THAN 1.95 SP.GR.

Specific gravity of solution (1.95 ± 0.01)		
wt. of lightweight particles	(0.1 g)	
weight of + #4 material	(0.1 g)	
% lightweight particles		
SPECIFICATION maximum		

- #4 % PARTICLES LESS THAN 1.95 SP.GR.

Specific gravity of solution (1.95 ± 0.01)		1.95
wt. of lightweight particles	(0.1 g)	1.6
weight of - #4 material	(0.1 g)	274.3
% lightweight particles		0.6%
SPECIFICATION maximum		1.0%

Coarse	1.65	x % Retain/Desigr	64.4	1.06
Fine	0.88	x % Pass/Design	35.6	0.31
		Total/Combined - #200		1.4%

- #4 Gradation check within 0.3 % of the _____ 0.2%

Na.Rock _____ Natural Fines _____ Cr.Fines _____
Cr.Rock _____ Natural Sand _____ Ma.Sand _____
Filler _____ Spencer Add Rock _____

CRUSHED PARTICLES TEST

weight of crushed pieces	(0.1 g)	
weight of total + #4 sample	(0.1 g)	
percent of crushed pieces	(%Whole)	
SPECIFICATION 2 or more FF, min.		

COMMENTS: _____

Figure 3

Test For Amount of Material Finer Than a No. 200 Sieve

1. Scope:

This test covers the determination of the amount of material finer than a #200 (0.075 mm) sieve.

2. Apparatus:

2.1 Scale or Balance having the capacity to weigh any sample which may be tested utilizing this procedure and readable to the nearest 0.1 gram.

2.2 Sieves. A nest of two sieves with the lower being a #200 (0.075 mm) sieve and the upper being a sieve with openings in the range of #8 (2.36 mm) to #16 (1.18 mm), both conforming to the requirements of AASHTO M 92.

2.3 Container. A pan or vessel of a size sufficient to contain the sample covered with water and to permit vigorous agitation without loss of material or water.

2.4 Drying oven capable of maintaining a temperature of 230° ±9°F (110° ±5°C).

3. Procedure:

3.1 Obtain samples in accordance with SD 201.

3.2 The size of the specimen shall conform to the following:

Note: Nominal maximum size of particle is denoted by the smallest sieve opening listed below, through which 90% or more of the sample being tested will pass.

Nominal Maximum Size of Particles	Minimum Weight of Sample, Grams
#4 (4.75 mm)	500
3/8" (9.50 mm)	1000
1/2" (12.5 mm)	2000
3/4" (19.0 mm)	2500
1" (25.0 mm)	3500
1 1/2" (37.5 mm) & above	5000

3.3 Dry the sample in an oven at 230° ±9°F (110° ±5°C) or in accordance with SD 108. Weigh the material to the nearest 0.1 gram and dry it to a constant weight.

3.4 Place the sample in the container and add enough water to cover it. Agitate the sample with sufficient vigor to result in complete separation of all particles finer than the #200 (0.075 mm) sieve from the coarser particles, and to bring the fine material into suspension. Pour the wash water containing the suspended and dissolved solids over the nest of sieves. Repeat the operation until the wash water is clear.

3.5 Dry the washed aggregate to a constant weight (as defined in section 3.3 above) in an oven at 230° ±9°F (110° ±5° C) or in accordance with SD 108 .

Note: If the material being tested also requires testing in accordance with SD 216 and/or SD 218, material from this test may be used to eliminate the need for additional testing specimens.

4. Report:

4.1 Calculate the amount of material passing a #200 (0.075 mm) sieve by washing as follows:

$$\frac{\text{(Original dry weight - weight after washing)}}{\text{Original dry weight}} \times 100 = \%\text{ of material finer than \#200 (0.075 mm) sieve}$$

4.2 Percentages shall be reported to the whole number or decimal required by the specification.

5. References:

AASHTO M 92
SD 108
SD 201
SD 216
SD 218
DOT-3

Liquid Limit, Plastic Limit and Plasticity Index

1. Scope:

This test is for determining the Liquid Limit, Plastic Limit and the Plasticity Index of soils and granular materials. Referee tests will be performed in accordance with AASHTO T-89 and T-90.

The Liquid Limit is the water content at which a soil passes from a plastic to a liquid state.

The Plastic Limit is the lowest water content at which a soil remains plastic.

The Plasticity Index is the numerical difference between the Liquid Limit and the Plastic Limit.

The word "soil" in these tests shall mean the minus #40 (0.425 mm) sieve material.

2. Apparatus:

2.1 Balance having a capacity of at least 100 g sensitive and readable to .01 gram.

2.2 Containers. Containers, such as metal cans with lids, which will prevent loss of moisture prior to and during weighing.

2.3 Drying oven. Ovens, hot plates or other suitable devices for drying the samples at 230°F ±9°F (110°C ±5°C).

2.4 Evaporating dish. A porcelain dish used for mixing the soil and water.

2.5 Liquid Limit device conforming to specifications as described in AASHTO T-89.

2.6 Grooving tool. A combined grooving tool and gauge as described in AASHTO T-89.

2.7 Plastic wash bottle with jet opening for adding water to the soil.

2.8 Pulverizing apparatus shall be a mortar and rubber covered pestle or a mechanical device consisting of a mortar of suitable size and shape and a power-driven, rubber covered muller for breaking up soil particles without reducing individual grain size.

2.9 Splitter. A riffle or adjustable chute splitter for reducing the size of the sample (SD 213).

2.10 Sieves. Sieves shall conform to AASHTO M-92.

2.11 Spatula. A spatula having a flexible steel blade approximately 3" (75 mm) in length and 3/4" (19 mm) in width.

2.12 Spoon. An appropriate size spoon for mixing and transferring the dry soil.

2.13 Surface for rolling. A ground glass plate or a piece of smooth paper laying on a smooth, horizontal surface.

3. Procedure:

For Disturbed Soil Samples

3.1 Obtain a dry sample of minus #4 (4.75 mm) sieve material that is of adequate size to produce at least 100 grams of minus #40 (0.425 mm) sieve material.

3.2 Sieve the material on a #40 (0.425 mm) sieve.

3.3 Pulverize the material retained on the #40 (0.425 mm) sieve using the mortar and rubber covered pestle or the power driven muller. If the sample contains brittle particles, the pulverizing operation shall be done carefully and with just enough pressure to free the finer material that adheres to the coarser particles.

For Aggregate Samples

3.4 Begin by weighing the sample to the nearest 0.1 gram and record it as "Wt. minus #4" on the worksheet. Place the material on a #40 (0.425 mm) sieve with a pan below the sieve and agitate them for a period of time. [The use of a relief sieve, #20 (0.850 mm) or #30 (0.600 mm), is encouraged above the #40 (0.425 mm) to prevent overloading.] Place the material retained on the sieves into a pulverizing mechanism (which shall consist of a mortar and rubber covered pestle or a power driven muller) and carefully pulverize the material.

Alternately sieve and pulverize the material until not more than 1% will pass the #40 (0.425 mm) sieve during 1 minute of sieving.

Weigh the material in the pan to the nearest 0.1 gram and record it as Wt. minus #40 on the worksheet. Calculate the percentage of the sample which passed through the sieve by dividing the "Wt. minus #40" by the "Wt. minus #4" and then multiplying this percentage by the accumulative percent passing the #4 (4.75 mm) sieve in the sieve analysis. Compare this percentage to the accumulative percentage of material that passed the #40 (0.425 mm) sieve in the sieve analysis. These should compare within ±3.0%. If the difference is more than 3.0% above the sieve analysis percentage, a new sample should be prepared and sieved, if it is more than 3.0% below the percentage passing in the sieve analysis, more pulverizing and sieving is required and the results recalculated.

NOTE: The variation should not be more than 3.0%.

3.5 Adjust the cup of the Liquid Limit device to a 10 mm drop. (The square end of the grooving tool handle is 10 mm.) Secure the adjustment plate by tightening the screws. With the gauge still in place, check the adjustment by revolving the crank rapidly several times. If the adjustment is correct, a slight ringing sound will be heard when the cam strikes the cam follower. If the cup is raised off the gauge or no sound is emitted, further adjustment is necessary.

3.6 Mix the sample of minus #40 (0.425 mm) material thoroughly and transfer 50 to 100 g to the evaporating dish. Add 15 to 20 mL of water by alternately and repeatedly stirring, kneading and chopping with a spatula, allowing time for moisture to soak into the soil. (Allow 5 to 10 minutes, with the longer time used for material slow to absorb water.) Make further additions of water in increments of 1 to 3 mL. Mix each increment of water thoroughly as previously described before adding another increment. Once testing has begun, no additional dry soil shall be added to the moistened soil. The cup of the Liquid Limit device shall not be used for mixing.

When sufficient water has been thoroughly mixed with the soil to form a uniform mass of stiff consistency, place an adequate quantity of this mixture in the cup above the spot where the cup rests on the base. Squeeze and spread this mixture with the spatula to level and at the same time trimmed to a depth of approximately 10 mm at the point of maximum thickness. Use as few strokes of the spatula as possible, taking care to prevent entrapment of air bubbles within the mass.

Divide the soil in the cup of the mechanical device with a firm stroke of the grooving tool, along the diameter through the centerline of the cam follower, forming a clean sharp groove of the proper dimensions [Figure 1]. To avoid tearing the sides of the groove or slipping of the soil cake within the cup, up to 6 strokes (from front to back or back to front, counting as 1 stroke) shall be permitted.

NOTE: At this point, spilled portions of moistened soil shall be wiped from the edges of the cup and base of the machine to ensure a clean surface on which the cup will fall.

Lift and drop the cup containing the soil by turning the crank at a rate of two revolutions per second until the sides of the groove come in contact at the bottom of the groove for a distance of 1/2" (12.5 mm), [Figure 2]. Do not hold the base of the machine with the hand while turning the crank.

NOTE: Some soils tend to slide on the surface of the cup instead of flowing. If this occurs, remove the material from the cup, add more water, remix and repeat the test. If the soil continues to slide on the cup at a lesser number of blows than 25, the test is not applicable and a note should be made that the liquid limit could not be determined.

Restrict the accepted number of blows for groove closure to between 22 and 28 blows. Record the number of blows for the accepted closure. Remove a slice of soil (8 grams minimum) approximately the width of the spatula, extending from edge to edge of the soil cake at right angles to and including that portion of the groove where the closure took place, and place it in a container. Promptly weigh and record to the nearest 0.01 g, the weight of the can and wet soil. Dry to a constant weight as per SD 108.

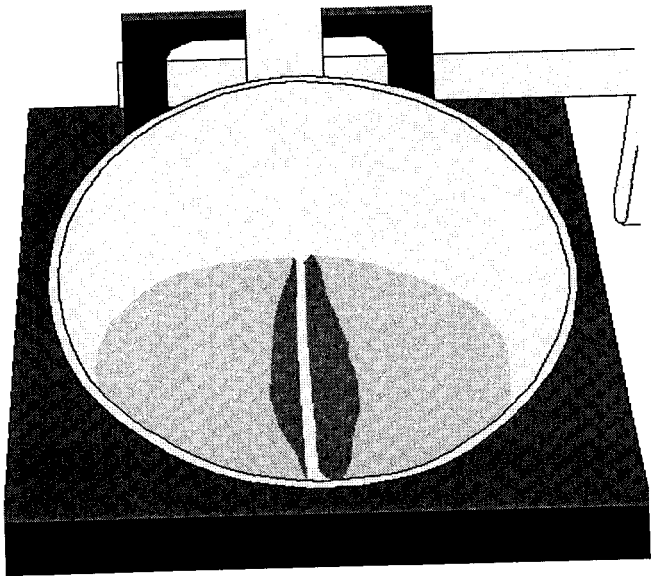


Figure 1

SOIL CAKE GROOVED FOR TEST

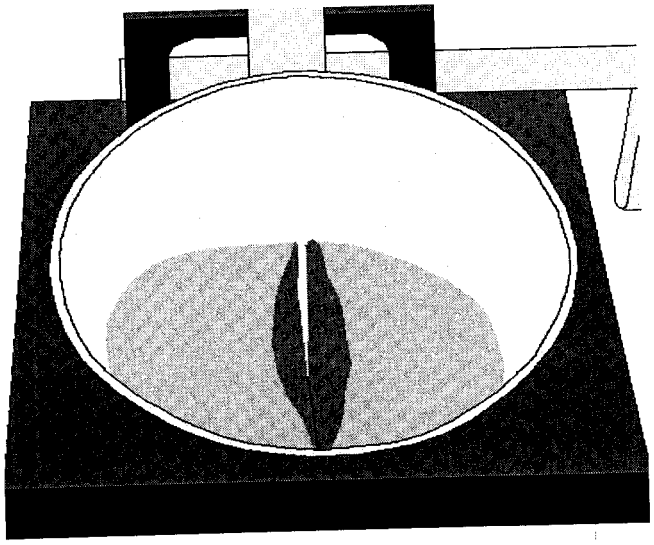


Figure 2

SOIL CAKE AFTER NORMAL TEST

3.7 Plastic Limit.

Take a sample weighing a minimum of 8 grams from the wet material in the evaporating dish used for the Liquid Limit test. Take the sample at any stage of the mixing process when the material becomes plastic enough to be shaped without excessively sticking to the fingers when squeezed. Set this sample aside until the Liquid Limit test has been completed.

Select a 1.5 to 2.0 gram portion from the 8 gram sample and squeeze and form this into an ellipsoidal-shaped mass. Roll this mass between the fingers and the ground-glass plate or a piece of smooth paper (do not use paper towels) laying on a smooth horizontal surface with just sufficient pressure to roll the mass into a uniform thread approximately 1/8" (3 mm) in diameter throughout its length [Figure 3]. When the diameter of the thread reaches 1/8" (3 mm), break it into 6 or 8 pieces, squeeze the pieces together into a uniform mass roughly ellipsoidal in shape and re-roll. The rate of rolling shall be between 80 and 90 strokes per minute, counting a stroke as one complete motion of the hand forward and back to the starting position.

NOTE: If 1/8" cannot be attained after repeated rolldown attempts, sample is NP.

Continue this alternate rolling to a thread, gathering together, kneading and re-rolling until the thread crumbles under the pressure required for rolling [Figure 4].

The crumbling may occur when the thread has a diameter greater than 1/8" (3 mm). This shall be a satisfactory end point, provided the soil has been previously rolled into a 1/8" (3 mm) diameter thread.

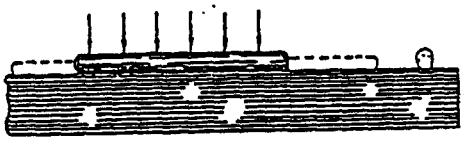


Figure 3

Figure 4

3.8 Gather all the crumbled soil together and place it in a tared container for weighing. This requires an additional sample to be taken and the steps in paragraph 3.7 followed again. Be sure the

lid is on the container to prevent evaporation while the additional material is prepared.

Weigh and record the weight of the container and wet soil to the nearest 0.01 gram. Dry the sample to a constant weight as per SD 108.

4. Report:

4.1 Calculation of the Liquid Limit

A. Calculate the moisture content to the nearest 0.1% of the oven-dried weight as follows:

$$\% \text{ Moisture} = \frac{\text{Weight of Water}}{\text{Weight of Oven-dried Material}} \times 100$$

B. Convert the percent of moisture to the Liquid Limit using the following conversion factors.

# of blows		factor	# of blows		factor
22	=	0.9846	26	=	1.0050
23	=	0.9899	27	=	1.0100
24	=	0.9952	28	=	1.0138
25	**=**	**1.0000**			

C. Record the Liquid Limit to the nearest 0.1% on the worksheet.

4.2 Calculation of the Plastic Limit.

A. Calculate the Plastic Limit as follows:

$$\text{Plastic Limit} = \frac{\text{Weight of Water}}{\text{Weight of Oven-dried Material}} \times 100$$

B. Record the Plastic Limit to the nearest 0.1% on the worksheet.

4.3 Calculation of the Plasticity Index.

A. Calculate the Plasticity Index as follows:
Plasticity Index = Liquid Limit – Plastic Limit

B. Record the Plasticity Index to the nearest 0.1% on the worksheet.

4.4 Report the Liquid Limit and Plasticity Index to the whole number or decimal required by the specifications.

5. References:

AASHTO T 89
AASHTO T 90
AASHTO M 92
SD 202
SD 213

SCREEN ANALYSIS AND P.I. WORKSHEET

DOT - 3
9-02

FILE NUMBER 15.4

COUNTY Armstrong PROJECT F 0037(4)196 PCN 8836

SAMPLE NO. 6 DATE SAMPLED 8/8/1999 DATE TESTED 8/8/1999

SAMPLED BY J. Smith TESTED BY J. Smith CHECKED BY CS

MATERIAL TYPE Asph. Conc. Class E Type 1 SOURCE R. Jones Pit

WEIGHT TICKET NUMBER OR STATION 76421 LIFT Final

% moist. = (wet wt. 5235.1 - dry wt.) / dry wt. x 100 = 3.5%

ORIGINAL DRY SAMPLE WT. (0.1g) 5058.2

sieve size mm	sieve size in	F.M. *	Retained (0.1g)	% total ret. (0.1%)	Acc.% pass. (0.1%)	Acc.% pass. (rounded)	SPEC REQ.
50.0	2						
37.5	1 1/2						
31.5	1 1/4						
25.0	1				100.0	100	**100**
19.0	3/4		30.3	0.6	99.4	99	**97-100**
16.0	5/8		159.7	3.2	96.2	96	
12.5	1/2		620.1	12.3	83.9	84	**76-90**
9.5	3/8	*	454.9	9.0	74.9	75	
6.3	1/4		354.6	7.0	67.9	68	
4.75	#4	*	345.4	6.8	61.1	61	**57-67**
PAN			3090.1	61.1	wt. before washing(0.1 g)		1069.3
TOTAL			5055.1	100.0	wt. after washing (0.1 g)		1058.5
					loss from washing		10.8
					% - #200		1.01

+ #4 Gradation Check
within 0.3% of the orginal dry wt. 0.1%

L. L., P. L., and P. I.

		L.L.	P.L.
a. can number		24	25
b. wt. can + wet soil	(.01 g)	40.47	31.42
c. wt. can + dry soil	(.01 g)	36.79	29.50
d. wt. of water (b - c)	(.01 g)	3.68	1.92
e. wt. of can	(.01 g)	18.47	18.63
f. wt. of dry soil (c - e)	(.01 g)	18.32	10.87
g. Liquid Limit(d/f x j x 100)	(0.1)	20.1	N.A.
h. Plastic Limit (d/f x 100)	(0.1)	N.A.	17.7
i. P. I. (g - h)	(0.1)	2.4	
Liquid Limit (g. rounded)		20	N.A.
Plasticity Index (i. rounded)		2	

j. corr. # blows 25 22 = 0.9846, 23 = 0.9899, 24 0.9952
25 = 1.0000, 26 = 1.0050, 27 = 1.0100, 28 = 1.0138

wt. - #40 111.5 ÷ wt. - #4 321.6 x % pass.#4 21.2%
(± 3.0% VARIABLE of Acc. % pass. (0.1%) on the #40)

SPECIFICATION L.L. max.	25
SPECIFICATION P.I. max.	3

Design Mix F.M. _____ (Tol. ± 0.2)

sieve size mm	sieve size #		Retained (0.1g)	% total ret.(0.1%)	% total x % pa.#4(0.1%)	Acc.% pass. (0.1%)	Acc.% pass. (rounded)	REQ.
2.36	8	*	104.1	20.0	12.2	48.9	49	42-52
2.00	10							
1.18	16	*	83.4	16.0	9.8	39.1	39	32-42
0.850	20							
0.600	30	*	113.3	21.7	13.3	25.8	26	
0.425	40		33.2	6.4	3.9	21.9	22	14-24
0.300	50	*						
0.180	80		44.6	8.5	5.2	16.7	17	
0.150	100	*						
0.075	200		90.4	17.3	10.6	6.1	6.1	4.0-8.0
PAN	dry		2.5	52.5	6.15	wt. before washing(0.1 g)		521.8
PAN	wash		50.0	10.06		wt. after washing (0.1 g)		471.8
TOTAL		*	521.5			loss from washing (- #200)		50.0

+ #4 % PARTICLES LESS THAN 1.95 SP.GR.

Specific gravity of solution (1.95 ± 0.01)		1.96
wt. of lightweight particles	(0.1 g)	30.3
weight of + #4 material	(0.1 g)	1921.4
% lightweight particles	(0.1%)	1.6%
SPECIFICATION maximum		2.0%

- #4 % PARTICLES LESS THAN 1.95 SP.GR.

Specific gravity of solution (1.95 ± 0.01)		1.96
wt. of lightweight particles	(0.1 g)	5.2
weight of - #4 material	(0.1 g)	304.1
% lightweight particles	(0.1%)	1.7%
SPECIFICATION maximum		2.0%

Coarse	1.01 x % Retain/Desigr	38.9	0.39	- #4 Gradation check
Fine	10.06 x % Pass/Design	61.1	6.15	within 0.3 % of the 0.1%
	Total/Combined - #200		6.5	wt. before washing

Na.Rock 17% Jones Natural Fines 45% Jones Cr.Fines 23%
Cr.Rock _____ Natural Sand _____ Ma.Sand _____
Filler _____ Spencer Add Rock 15%

CRUSHED PARTICLES TEST

weight of crushed pieces	(0.1 g)	786.4
weight of total + #4 sample	(0.1 g)	1008.9
percent of crushed pieces	(%Whole)	78%
SPECIFICATION 2 or more FF, min.		50%

COMMENTS:

Figure 5

Method of Test for Percentage of Particles of Less Than 1.95 Specific Gravity in Fine Aggregates

1. Scope:

This test is for determining the percentage of lightweight particles in fine aggregate.

2. Apparatus:

2.1 Scale or Balance having the capacity to weigh any sample which may be tested utilizing this procedure and readable to the nearest 0.1 gram.

2.2 Sieves. A #30 (0.600 mm) sieve conforming to the requirements of AASHTO M 92.

2.3 Strainer. A strainer with openings not larger than a #30 (0.600 mm) mesh.

2.4 Beakers and graduate. Two 1000 mL glass beakers and one glass graduate of at least 250 mL capacity.

2.5 Containers suitable for drying the aggregate sample.

2.6 Hydrometer for measuring the specific gravity of the liquid, readable to 0.01.

2.7 Zinc chloride solution having a specific gravity of 1.95 ±0.01.

2.8 Drying oven capable of maintaining a temperature of 230° ±9°F (110° ±5°C).

3. Procedure:

3.1 Using the graduate and hydrometer, check the specific gravity of the zinc chloride solution and record on the worksheet to the nearest 0.01.

3.2 Obtain a 250 to 350 g sample in accordance with SD 201 and dry in an oven at 230° ±9°F (110° ±5°C). Weigh the material to the nearest 0.1 gram and dry it to a constant weight as per SD 108.

06

3.3 Screen the material on a #30 (0.600 mm) sieve and save the retained portion for the test.

3.4 Place approximately 600 mL of the solution in a glass beaker. The material is poured into the solution and at the same time stir the solution with a spoon. Continue stirring to insure that all of the material is in suspension. Allow the material to settle until there is a defined cleavage plane between the rising and settling material.

3.5 Decant the solution over the strainer into a glass beaker. Continue decanting until the settled material appears near the lip of the beaker.

3.6 Pour the solution back into the settled material at the same time stirring with a spoon to bring all material into suspension. Decant the solution as described in paragraph 3.5.

3.7 Thoroughly wash the material retained on the strainer to remove all zinc chloride. Dry the material to a constant weight in an oven at 230° ±9°F (110° ±5°C). Weigh the material to the nearest 0.1 gram.

4. Report:

4.1 The approximate percentage of lightweight particles is calculated in the following manner:

$$\% \text{ Lightweight Particles} = \frac{\text{Wt. of Decanted Particles}}{\text{Wt. of Original Dry Sample}} \times 100$$

4.2 Report the percentage of lightweight particles to the nearest 0.1%.

5. References:

AASHTO M 92
SD 201

Method of Test for Specific Gravity and Absorption Of Fine Aggregate

1. Scope:

This test is for determining the Bulk Specific Gravity and Absorption of fine aggregate.

2. Apparatus:

2.1 Scale or Balance having the capacity to weigh any sample which may be tested utilizing this procedure and readable to the nearest 0.1 gram.

2.2 Flask. A volumetric flask having a capacity of 500 mL with a known tare weight.

2.3 Mold. A metal, cone shaped mold with the following dimensions: top, 1 ½" (38 mm); bottom, 3 ½" (90 mm); height, 2 7/8" (72 mm).

2.4 Tamper. A metal tamping rod weighing 12 oz. (340 g) and having a flat circular tamping face 1" (25 mm) in diameter.

2.5 Drying oven capable of maintaining a temperature of 230° ±9°F (110° ±5°C).

2.6 Funnel. A small funnel to introduce the fine aggregate into the flask.

3. Procedure:

3.1 Obtain a sample of at least 1000 g in accordance with SD 201.

3.2 Dry the sample in an oven at 230° ±9°F (110° ±5°C). Weigh the material to the nearest 0.1 gram and dry it to a constant weight as per SD 108.

3.3 Allow the sample to cool to a comfortable handling temperature, cover with water, either by immersion or by the addition of at least 6% moisture to the fine aggregate, and permit to stand for 15 to 19 hours. When the absorption and specific gravity values are to be

used in proportioning concrete mixtures with aggregates used in their naturally moist condition, the requirement for initial drying to constant weight may be eliminated. If the surface of the particles have been kept wet, the 15 hours of soaking may also be eliminated.

NOTE: Values for absorption and specific gravity in the saturated surface dry condition may be significantly higher for aggregate not oven-dried before soaking than for the same aggregate treated in accordance with paragraph 3.2 and 3.3.

3.4 Decant excess water with care to avoid loss of fines, spread on a flat non-absorbent surface exposed to a gently moving current of warm air, and stir frequently to secure homogenous drying. Continue until the test specimen approaches a free flowing condition.

3.5 Test the material to determine if surface moisture is present with the cone and tamper. Hold the mold firmly on a smooth non-absorbent surface with the large diameter down. Place a portion of the partially dried fine aggregate loosely in mold by filling it to overflowing and heaping additional material above the top of the mold by holding it with cupped fingers of the hand holding the mold.

Lightly tamp the fine aggregate into the mold with 25 light drops of the tamper. The height of each drop shall be about 1/4" (6 mm) above the surface elevation of the fine aggregate. Distribute the drops over the entire surface of the fine aggregate.

Remove the loose sand from the base of the mold and lift it vertically. If surface moisture is still present, the fine aggregate will retain the shape of the mold. When the fine aggregate slumps slightly, it indicates that it has reached a surface dry condition. [It is intended that the first trial of the cone test be made with some surface water in the specimen. If the first test indicates that moisture is not present on the surface, mix a few milliliters of water with the fine aggregate; allow to stand covered for approximately 30 minutes, then proceed with the cone test.]

3.6 Immediately weigh a 500.0 g sample of the surface dry material and place it in the flask. Add water at 73.4 ±3°F (23.0 ±1.7°C) to the material and roll the flask to eliminate air bubbles. After all air bubbles have been removed, place the flask in a constant temperature bath at 73.4 ±3°F (23.0 ±1.7°C) for 1 hour.

Fill the flask with water to the 500 mL mark and weigh the flask, water and fine aggregate to the nearest gram.

Remove the fine aggregate from the flask and dry to a constant weight. Weigh the dry aggregate to the nearest 0.1 gram. In lieu of drying the material from the flask, a second 500.0 gram of surface dry sample may be used to determine the dry weight.

4. Report:

4.1 Bulk Specific Gravity :

Calculate the bulk specific gravity, 73.4/73.4°F (23/23°C), as defined in M132 as follows:

$$\text{Bulk Sp. Gr.} = A/(B + S - C)$$

where:

A = mass of oven-dry specimen in air, g;

B = mass of pycnometer filled with water, g;

C = mass of pycnometer with specimen and water to calibration mark, g; and

S = mass of saturated surface-dry specimen, g;

Bulk Specific Gravity (Saturated Surface-Dry Basis)

Calculate the bulk specific gravity, 73.4/73.4°F (23/23°C), on the basis of mass of saturated surface-dry aggregate as follows:

$$\text{Bulk Sp. Gr. (saturated surface-dry basis)} = S/(B + S - C)$$

Apparent Specific Gravity

Calculate the apparent specific gravity, 73.4/73.4°F (23/23°C), as defined in M132 as follows:

$$\text{Apparent Sp. Gr.} = A/(B + A - C)$$

Absorption

Calculate the percentage of absorption, as defined in ASTM C 125, as follows:

Absorption, percent = [(S – A)/A] X 100

4.2 Report the Concrete specific gravity to the nearest 0.01 and the absorption to the nearest 0.1%. Report the Asphalt specific gravity to 0.001 and absorption to the nearest 0.1%.

5. References:

AASHTO T 84
AASHTO M 132
ASTM C 125
SD 108
SD 201

Method of Test for Specific Gravity and Absorption of Coarse Aggregate

1. Scope:

This test is for determining the Bulk Specific Gravity and the Absorption of coarse aggregate.

The Bulk Specific Gravity, saturated surface dry test is the method used for the determination of the weight per ft^3 (m^3) of Riprap.

2. Apparatus:

2.1 Scale or Balance having the capacity to weigh any sample which may be tested utilizing this procedure and readable to the nearest 0.1 gram.

2.2 Wire basket. A wire basket, large enough to hold the coarse aggregate sample, with #6 (3.35 mm) mesh or smaller openings.

2.3 Water tank. A pail or tank into which the sample is suspended in water at 73.4°F ±3°F (23.0 ±1.7°C) for weighing.

2.4 Sieves. A #4 (4.75 mm) sieve conforming to AASHTO M 92.

2.5 Drying oven capable of maintaining a temperature of 230° ±9°F (110° ±5°C).

3. Procedure:

3.1 Coarse Aggregate.

A. Obtain a sample in accordance with SD 201. The minimum sample specimen weight shall be as shown in the following table.

Nominal Maximum Size, in (mm)	Minimum Mass of Test Sample, lb. (kg)
1/2 (12.5) or less	4.4 (2)
3/4 (19)	6.6 (3)
1 (25.0)	8.8 (4)
1 ½ (37.5)	11 (5)
2 (50)	18 (8)
2 ½ (63)	26 (12)
3 (75)	40 (18)
3 ½ (90)	55 (25)
4 (100)	88 (40)
4 ½ (112)	110 (50)
5 (125)	165 (75)
6 (150)	276 (125)

B. Screen and wash the sample on the #4 (4.75 mm) sieve.

C. Immerse the plus #4 (4.75 mm) sieve material in water for 15 to 19 hours.

D. Remove the specimen from the water and roll in an absorbent cloth until all visible films of water are removed from the particles.

E. Weigh and record the weight of the material to the nearest 0.1 gram.

F. Place the specimen in the wire basket and weigh and record the weight to the nearest 0.1 g of the material suspended in water at 73.4°F ±3°F (23.0°C ±1.7°C).

G. Dry the material to a constant weight and weigh to the nearest 0.1 gram.

3.2 Riprap.

A. Select a representative sample in accordance with the table shown in 3.1 A. (If small pieces are not available, select a larger piece that can be broken down in the laboratory).

B. Wash the specimen to remove dust and then immerse it in water for 15 to 19 hours.

C. Continue with paragraph 3.1. D. thru 3.1 G.

4. Report:

4.1 Bulk Specific Gravity

Calculate the bulk specific gravity, 73.4/73.4°F (23/23°C) as follows:

$$\text{Bulk Sp. Gr.} = A/(B - C)$$

where:

A = mass of oven-dry test sample in air, g,

B = mass of saturated-surface-dry test sample in air, g, and

C = mass of saturated test sample in water, g.

4.2 Bulk Specific Gravity (Saturated-Surface-Dry)

Calculate the bulk specific gravity, 73.4/73.4°F (23/23°C), on the basis of mass of saturated-surface-dry aggregate as follows:

$$\text{Bulk Sp. Gr. (saturated-surface-dry)} = B/(B - C).$$

4.3 Apparent Specific Gravity

Calculate the apparent specific gravity, 73.4/73.4°F (23/23°C), as follows:

$$\text{Apparent Sp. Gr.} = A/(A - C)$$

4.4 Average Specific Gravity Values

When the sample is tested in separate size fractions, the average value for bulk specific gravity, bulk specific gravity (SSD), or apparent specific gravity can be computed as the weighted average of the values as computed using the following equation:

$$G = \frac{1}{\frac{P_1}{100\ G_1} + \frac{P_2}{100\ G_2} + \ldots \frac{P_n}{100\ G_n}}$$

Where:

G = average specific gravity. All forms of expression of specific gravity can be averaged in this manner.

$G_1, G_2 \ldots G_3$ = appropriate specific gravity values for each size fraction depending on the type of specific gravity being averaged.

$P_1, P_2 \ldots P_n$ = mass percentages of each size fraction present in the original sample.

4.5 Absorption

Calculate the percentage of absorption, as follows:

Absorption, percent = [(B - A)/A] X 100.

4.6 Average Absorption Value

When the sample is tested in separate size fractions, the average absorption value is the average of the values as computed in Section 9.3, weighted in proportion to the mass percentages of the size fractions in the original sample as follows:

$$A = (P_1A_1/100) + (P_2A_2/100) + \ldots (P_nA_n/100)$$

Where:

A = average absorption, percent,

A1, A2 ... An = absorption percentages for each size fraction, and

P1, P2 ... Pn = mass percentages of each size fraction present in the original sample.

4.7 Report the specific gravity of coarse aggregate to the nearest 0.01 for concrete, nearest 0.001 for asphalt, and the absorption to the nearest 0.1% for both.

4.8 Report the unit weight of Riprap to the nearest whole lb./ft^3 (kg/m^3).

Unit Weight of Riprap = use formula shown in paragraph 4.2 above

5. References:

AASHTO T 85
AASHTO M 92
SD 201

Method of Test for Percentage of Crushed Pieces

1. Scope:

This test is for determining the percentage of pieces having one or more fractured faces. A fractured face is an angular, rough, or broken surface of an aggregate particle created by crushing, by other artificial means, or by nature.

2. Apparatus:

2.1 Scale or Balance having the capacity to weigh any sample which may be tested utilizing this procedure and readable to the nearest 0.1 gram.

2.2 Sieve. A #4 (4.75 mm) sieve conforming to AASHTO M 92.

2.3 Pans for washing and drying the samples.

2.4 Drying oven capable of maintaining a temperature of 230° ±9°F (110° ±5°C).

3. Procedure:

3.1 Obtain sample in accordance with SD 201.

3.2 The sample should be large enough to yield the minimum quantity of +#4 (4.75 mm) sieve material required by the table below. The sample includes all rock retained on the #4 (4.75 mm) sieve and above.

Nominal Maximum Size of Aggregate	Sample Size of Plus No. 4 Material
1" (25.0 mm)	1500 grams
3/4" (19.0 mm)	1000 grams
1/2" (12.5 mm)	650 grams
3/8" (9.5 mm)	500 grams

NOTE: Nominal maximum size of aggregate is denoted by the smallest sieve opening through which 90% or more of the sample being tested will pass.

3.3 The material used for this test may be the material used for the "Total -#200 materials" testing i SD 202. If a is used, screen and wash the material retained on the #4 (4.75 mm) sieve and above to remove fine material that may be adhering to it to aid in the visual inspection of the fractured faces. Following screening and washing, dry the material in an oven at 230 ±9° F (110 ±5° 06

C) to a constant weight as per SD 108 and weigh it to the nearest 0.1 gram.

3.4 Spread the aggregate on a flat clean surface and separate the particles not having the required number of fractured faces from those that have. Following are the definitions for a fractured face:

One Fractured Face

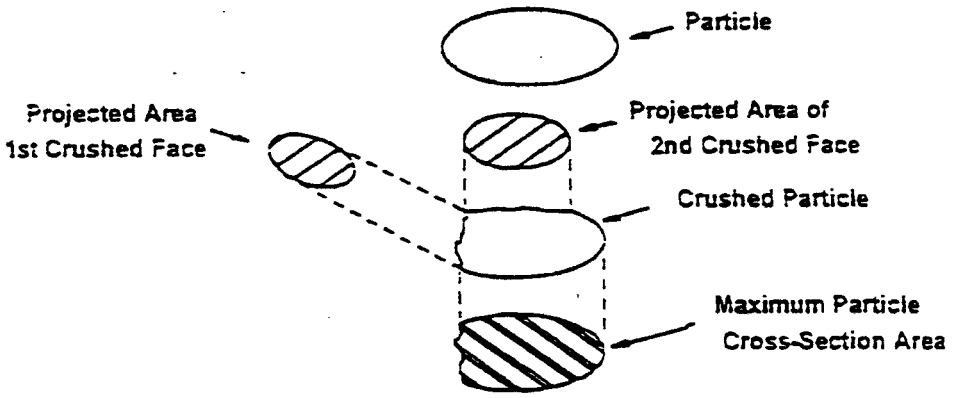
The particle face will be considered "fractured" only if it has a projected area of at least 25% of the maximum cross-sectional area of the particle and the face has sharp and well-defined edges.

Two Fractured Faces

The particle will be considered to have two "fractured faces" when the largest face has a projected area of at least 50% of the maximum cross-sectional area, and the other fractured face meets the 25% minimum requirement.

The maximum cross-sectional area of the particle would be the largest outline projected by the rock fragment when held under a light.

Weigh the crushed pieces to the nearest 0.1 gram.



Crushed Particle with two Fractured Faces

$$\text{Percent Crushed Particles Retained on \#4 (4.75 mm) sieve \& above} = \frac{\text{Wt. of Crushed Particles}}{\text{Wt. of Sample Retained on \#4 (4.75 mm) sieve \& above}} \times 100$$

4.2 Report the percent of Crushed Particles Retained on the #4 (4.75 mm) sieve and above to the nearest whole number.

5. References:

AASHTO M 92
SD 108
SD 201
SD 202

Procedure for Reducing Field Samples to Testing Size

1. Scope:

These procedures are for the reduction of field samples of aggregates to the appropriate size for testing.

2. Apparatus:

2.1 Mechanical Method.

A. Mechanical sample splitters, riffle type or adjustable chute type, with 3 receptacles large enough to hold the sample.

B. Sample splitters shall have an even number of equal width chutes. The number of chutes for coarse aggregate shall not be less than 8, and for fine aggregate, not less than 12. The chutes shall discharge alternately to each side of the splitter. The minimum width of the individual chutes shall be approximately 50% larger than the largest particles in the sample to be split. For fine aggregate a splitter having chutes 1/2" (13 mm) wide will be satisfactory when the entire sample passes the 3/8" (9.5 mm) sieve.

C. The splitter shall be equipped with a hopper or a straight edge pan, which has a width equal to or slightly less than the overall width of the assembly of chutes.

2.2 Quartering Method.

A. Canvas, heavy polyethylene or other suitable surface, or minimum of 24 x 24 x 4 pan.

B. Straightedge, scoop, shovel or trowel.

C. Broom or brush.

3. Procedure:

3.1 **Fine aggregate** to be split or quartered shall be dry or surface dry before reducing the sample to required size.

Fine Aggregate is defined as an aggregate in which the entire sample will pass the 3/8" (9.5 mm) Sieve.

Surface Dry condition may be determined, as a quick approximation, if the fine aggregate will retain its shape when molded in the hand, it may be considered to be wetter than saturated-surface dry.

If the moist sample is large, a preliminary split may be made using a mechanical splitter having wide chute openings 1-1/2" (38 mm) or more to reduce the sample to not less than 5000 grams. This portion is then dried and reduction to test sample size is completed.

Coarse Aggregates and Mixtures of Coarse and Fine Aggregates may be reduced to Test Sample Size using a mechanical splitter, in which the sample will flow smoothly without restriction or loss of material. The quartering method may be used without regard to moisture in the aggregates.

3.2 Mechanical Splitter.

A. Adjust splitter bars for required chute width.

B. Place sample in closed hopper, distributing as you pour, and level by hand until material is evenly distributed from side-to-side and from front to back in hopper.

C. Prior to splitting your sample, mix the sample by repetitive blending and mixing the entire sample (3 times) with the splitter.

D. Introduce the material by opening the gates of the hopper. The sample shall be fed at a controlled rate to the chutes. Sample will divide to half the original portion in each of the pans **[A] & [B]**.

> **NOTE: Reintroduce the portion of the sample [A] or [B] into the splitter as many times as necessary to reduce the sample to the size specified for intended test.**

E. To assure representative samples, split the Original sample into **[A]** & **[B]** into **[a]** & **[b]**, reverse **[a]** & **[b]** in splitter, combine **[B]** into **[b]** & **[a]**. As shown in Figure 2 .

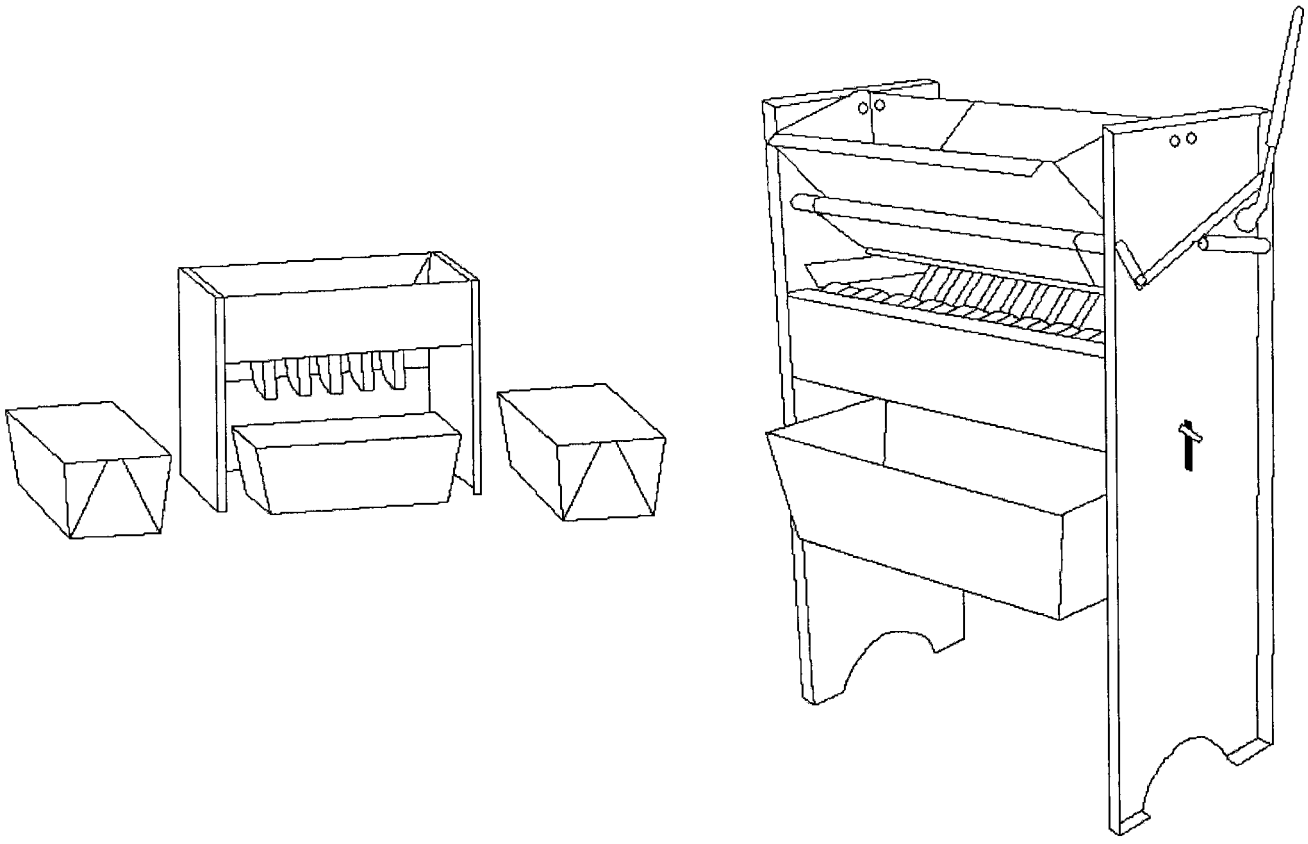
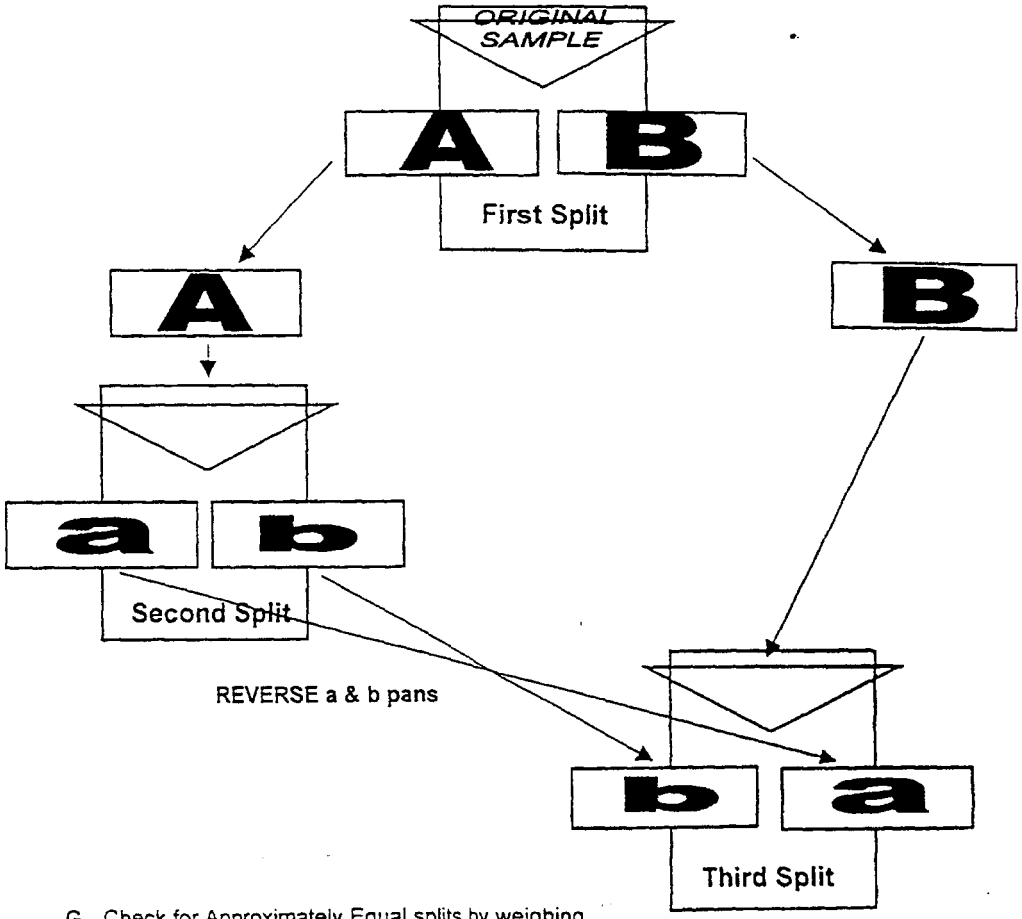


Figure 1



G. Check for Approximately Equal splits by weighing

RULE OF THUMB: *Coarse Aggregate splits within 500 grams or Fine Aggregate within 30 Grams.*

H. Sample **[b]** can be saved as Backup or reduction of other tests.
If Four samples that meet the size of intended test are needed, repeat the above process on **[a]** & **[b]** to end up with four approximately equal splits as shown below.

1	2	3	4
TEST SAMPLE OR QC SAMPLE	BACKUP SAMPLE OR QA SAMPLE	TEST SAMPLE OR IAS SAMPLE	BACKUP SAMPLE

Figure 2

3.3 Quartering.

A. Place the sample on a hard, clean, level surface where there will be neither loss of material nor the addition of foreign material. Mix the material thoroughly by turning the entire sample over three times. With the last turning, shovel the entire sample into a conical pile by depositing each shovelful on top of the preceding one. Carefully flatten the conical pile to a uniform thickness and diameter by pressing down the apex with a shovel so that each quarter sector of the resulting pile will contain the material originally in it. The diameter should be approximately 4 to 8 times the thickness. Divide the flattened mass into 4 equal quarters with a shovel or trowel and remove 2 diagonally opposite quarters, including all fine material, and brush the cleared spaces clean. Successively mix and quarter the remaining material until the sample is reduced to the desired size. (Figure 3)

B. As an alternative when the floor surface is uneven, the field sample may be placed on a canvas blanket and mixed with a shovel as described in paragraph 3.3.A. or by alternately lifting each corner of the canvas and pulling it over the sample toward the diagonally opposite corner causing the material to be rolled. Flatten and divide the sample as described in paragraph 3.3.A. or if the surface beneath the blanket is uneven, insert a stick or pipe beneath the blanket and under the center of the pile, then lift both ends of the stick, dividing the sample into 2 equal parts. Remove the stick, leaving a fold of the blanket between the divided portions. Insert the stick under the center of the pile at right angles to the first division and again lift both ends of the stick, dividing the sample into 4 equal parts. Remove 2 diagonally opposite quarters, being careful to clean the fines from the blanket. Successively mix and quarter the remaining material until the sample is reduced to the desired size. (Figure 4)

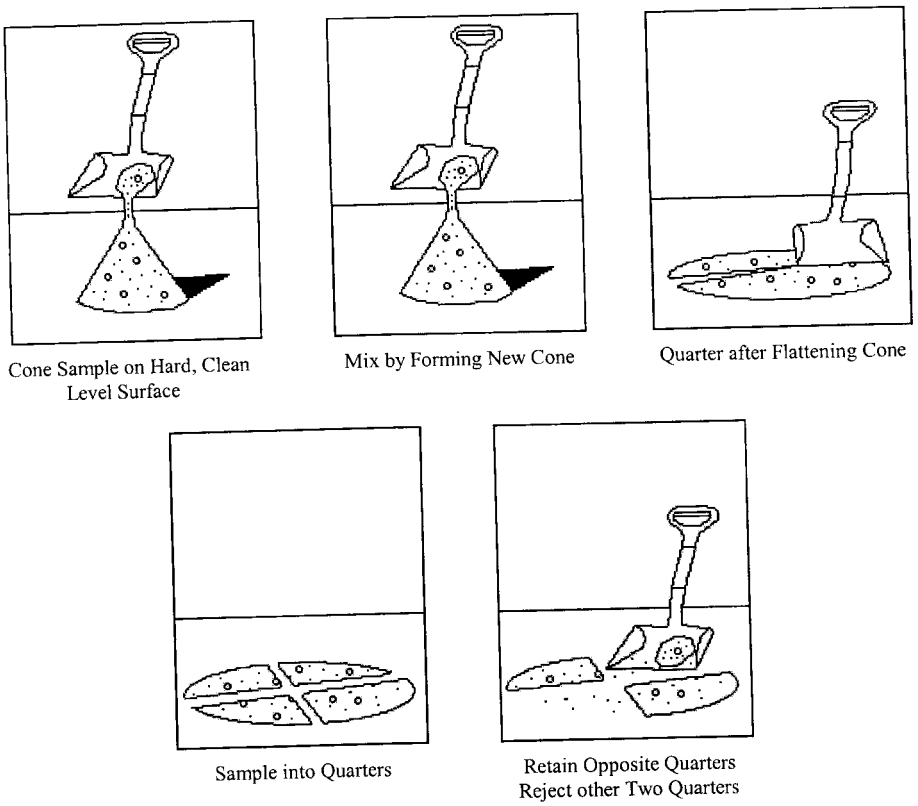


Figure 3

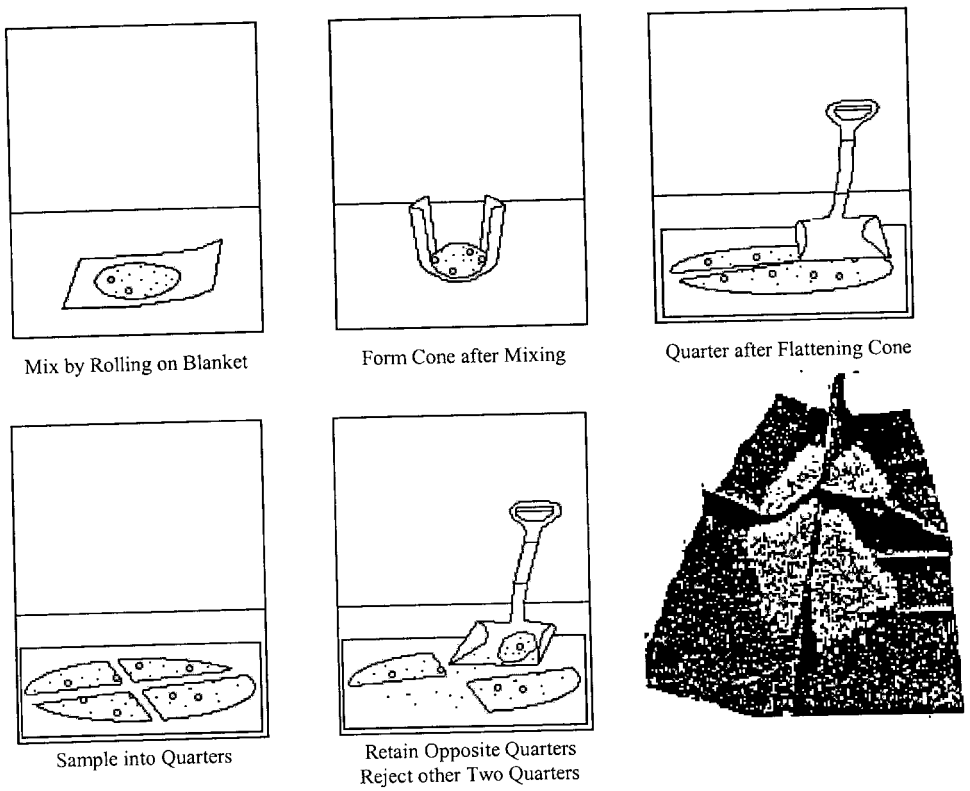


Figure 4

4. **Report:**

None required.

5. **References:**

AASHTO T 248

Method of Test for Percentage of Particles of Less Than 1.95 Specific Gravity in Coarse Aggregate

1. Scope:

This test is for determining the percentage of lightweight particles in coarse aggregate.

2. Apparatus:

2.1 Scale or Balance having the capacity to weigh any sample which may be tested utilizing this procedure and readable to the nearest 0.1 gram.

2.2 A suitable container and basket that will permit submerging the specimen to a minimum of 2" (50 mm) below the surface of the solution. The basket shall have openings not larger than a #8 (2.36 mm) mesh.

2.3 A #4 (4.75 mm) sieve conforming to AASHTO M 92.

2.4 A strainer with openings not larger than a #8 (2.36 mm) mesh.

2.5 A glass graduate of at least 250 mL capacity and a hydrometer for measuring the specific gravity of the liquid, readable to 0.01.

2.6 Zinc chloride solution having a specific gravity of 1.95 ±0.01.

2.7 Drying oven capable of maintaining a temperature of 230° ±9°F (110° ±5°C).

3. Procedure:

3.1 Using a graduate and hydrometer, check the specific gravity of the zinc chloride solution and record on the worksheet to the nearest 0.01.

3.2 Obtain a 1500 to 2000 g sample in accordance with SD 201. Weigh the material to the nearest 0.1 gram and dry it to a constant weight as per SD 108. The sample includes all rock above the #4 (4.75 mm) sieve.

06

3.3 Sieve the dry sample on a #4 (4.75 mm) sieve and weigh the material retained to the nearest 0.1 gram.

3.4 Place the material in the basket and lower into the zinc chloride solution. Stir the aggregate with a large spoon. Skim off the floating particles using a strainer and save them. Repeat this process until no additional particles surface.

NOTE: The solution in the tank should be approximately 3 times the volume of the aggregate.

3.5 Thoroughly wash the particles that have been skimmed off, dry to a constant weight in an oven at 230° ±9°F (110° ±5°C).

4. Report:

4.1 Calculate the percentage of lightweight particles in the following manner.

$$\% \text{ Lightweight Particles} = \frac{\text{Wt. of Lightweight Particles} \times 100}{\text{Wt. of Plus No. 4 (4.75 mm) Material}}$$

4.2 Report the percentage to the nearest 0.1%.

5. References:

AASHTO M 92
SD 201
SD 108

Procedure for Sodium Sulfate Soundness of Aggregates

1. Scope:

This test is for determining sodium sulfate soundness on coarse and fine aggregates.

2. Apparatus:

2.1 Shall be in accordance with ASTM C88 except:

A. Delete Section 4.2 and replace with '*Containers for Samples* – Containers will be in accordance with the procedure described in this method.'

3. Procedure:

3.1 Shall be in accordance with ASTM C88 except:

A. Section 8.1 – Delete the first sentence and replace with '*Samples in Solution* – Place the sample in the pan. Pour the sodium sulfate solution into the pan containing the sample to sufficiently cover the sample ½" (12.5 mm) for not less than 16 hours nor more than 18 hours.'

B. Section 8.2 – Delete the first sentence and replace with '*Samples After Immersion* – After each period, the sodium sulfate solution from the pan shall be poured off over a No. 50 (0.300 mm) sieve and any material remaining on the No. 50 (0.300 mm) sieve shall be returned to the original sample and placed in the drying oven.'

C. Section 8.4 – Delete the second and third sentences and replace with 'Wash the sample by placing the sample in the No. 50 (0.300 mm) sieve and rinse with water.'

4. Report:

4.1 Report the results to the nearest whole %.

5. References:

ASTM C 88

Method of Field Sampling Asphalt Materials

1. Scope:

This test covers the procedure for sampling Performance Graded Asphalt Binder, Emulsified Asphalt, Cutback Asphalt, etc.

2. Apparatus:

2.1 Containers.

1 quart (1 L) metal cans with screw tops used for PG 58-22, PG 58-28, PG 58-34, PG 64-22, PG 64-28, PG 64-34, PG 70-28, PG 70-34 and all other Performance Graded Binders, SC 800, MC 70, MC 800, MC 3000, RC 70, RC 800, RC 3000 and all other grades of Cutback Asphalt.

1/2 gallon plastic bottles used for SS1H, CSS1H, AE-150, AE-200, CRS2 and all other liquid emulsions.

2.2 The contractor furnished Bulkhead Sampling Valve [submerged] shall conform to the requirements shown in Figure 1. The size of the pipe may vary from the 3/4" (19 mm) shown.

2.3 The contractor furnished In-Line Asphalt Sampling Device shall conform approximately to the requirements shown in Figure 2.

The device shown is a detachable design to be installed in the unloading line between the truck transport or railroad car and the contractor's equipment. This device shall also be installed between the contractor's storage tank and the asphalt concrete Mix Plant. In-Line Sampling Valves may vary in configuration, pipe diameter and length.

In-Line Sampling Valves may be permanently mounted in the discharge line of the supply vehicle or contractor's unloading equipment, provided the following conditions are met.

A. The size, location and configuration are such that samples can be readily obtained.

B. Adequate provisions are made to keep the sample valve clean and operable.

2.4 Gloves, tongs, or other devices for handling the containers and valves.

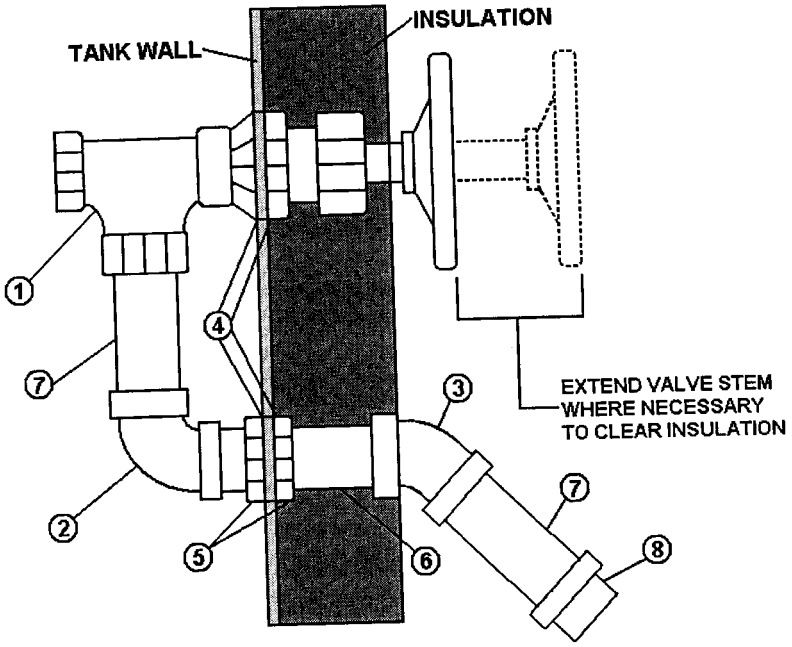
3. Procedure:

3.1 Bulkhead Sampling Valve.

A. Inspect the containers to insure that they are clean and dry.

B. Immediately after the beginning of the transfer of material, drain off approximately ½ gallon (2 L) of the asphalt and then completely fill the first container.

C. When approximately ½ of the load has been transferred, drain off approximately ½ gallon (2 L) of the asphalt and then completely fill the second container.



MOUNT IN LOWER HALF OF THE BULKHEAD AT LEAST 1' (300 mm) FROM THE SHELL

REF NO	DESCRIPTION	NO REQ
1	¾" (19 mm) "Vogt" P-9844 steel angle valve or similar, panel mounted	1
2	¾" (19 mm) steel or mall iron 90° elbow	1
3	¾" (19 mm) steel or mall iron 45° elbow	1
4	Asbestos Gaskets snug on the thread or wound with yarn	4
5	¾" (19 mm) 150# (70 kg) screwed M. I. lock nut	2
6	¾" X 3 ½" (19 mm X 85 mm) = parallel threaded steel pipe nipple [cut from ¾" (19mm) std. tank nipple if otherwise unobtainable]	1
7	¾" X 3" (19 mm X 75 mm) threaded steel pipe nipple	2
8	¾" (19 mm) mall iron pipe cap	

Figure 1

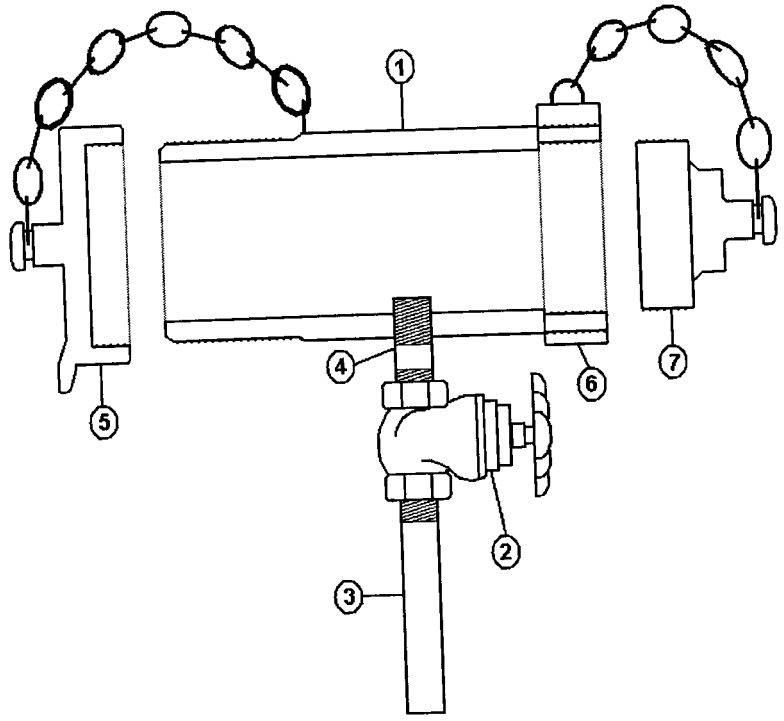
3.2 In-Line Sampling Valve.

A. Inspect the containers to insure they are clean and dry.

B. Truck Transport or Railroad Car – When approximately 1/3 of the load has been used or transferred, drain off ½ gallon (2 L) of asphalt and then completely fill the first container.

When approximately 2/3 of the load has been used or transferred, drain off ½ gallon (2 L) of asphalt and then completely fill the second container.

C. Between the Storage Tank and the Mix Plant – Drain off ½ gallon (2 L) of asphalt and then completely fill 2 one quart (1 L) sample containers.



REF NO	DESCRIPTION	NO REQ
1	3" X 10" (75 mm X 250 mm) steel pipe threaded outside at both ends and inside at one end	1
2	¾" (19 mm) steel gate valve	1
3	¾" X 3" (19 mm X 75 mm) steel nipple, threaded at one end	1
4	¾" X 2" (19 mm X 50 mm) steel close nipple	1
5	3" (75 mm) brass cap with chain	1
6	3" (75 mm) brass pipe coupling	1
7	3" (75 mm) brass pipe plug with chain	

Figure 2

3.3 Distributor Sampling.

A. Inspect the containers to insure they are clean and dry.

B. Method 1: Drain off 1 gallon (4 L) of asphalt through a nozzle on the spray bar and completely fill 2 containers.

C. Method 2: Take the sample from a nozzle on the spray bar after a portion of a load has been applied. Completely fill 2 containers.

3.4 General.

A. If the asphalt is delivered in a truck transport and pup combination, take **BOTH** of your samples from either one of the units. DO NOT take one can from one unit and the other from the other unit.

B. Tightly seal all sample containers, immediately after filling, using tape, if necessary.

C. The filled cans must not be submerged in, or cleaned with solvents, or solvent saturated rags. Spilled materials shall be wiped from the outside containers with clean dry cloths only.

D. Place the field sample number and project number on each container for the sample and tape the 2 containers together, i.e. 1A & 1B.

E. For other methods of sampling asphalt materials, use AASHTO T 40 or contact the Materials and Surfacing Office.

4. Report:

Certificate of Compliance and forms DOT-1 and DOT-2.

5. References:

AASHTO T 40
DOT-1
DOT-2

Method of Test for Determining the Moisture Content in Uncompacted Bituminous Paving Mixtures

1. Scope:

This test is for determining the amount of moisture in an uncompacted bituminous paving mixture.

2. Apparatus:

2.1 Container with cover suitable for a sample of hot uncompacted hot mix (cement can).

2.2 Convection oven capable of maintaining the temperature at 270° ± 10°F (132° ± 5°C).

2.3 Balance with a capacity of at least 5,000 grams, sensitive and readable to 0.1 gram. Use of a piece of wood or metal on the scale is recommended to protect the scale from the elevated temperatures.

2.4 Gloves.

3. Procedure:

3.1 Weigh and record the weight of a sample container and cover to the nearest 0.1 gram.

3.2 Obtain a representative 1,500 to 3,000 gram sample of uncompacted hot mix from the paver area in accordance with SD 312.

3.3 Place the sample in the container, put on the cover and transport back to the lab.

3.4 Weigh and record the weight of the container, cover and uncompacted hot mix to the nearest 0.1 gram. Subtract weight obtained in 3.1 above to determine the original weight of the uncompacted hot mix (which includes moisture). 06

3.5 Place the container and uncompacted hot mix without the cover in an oven set at 270° ± 10°F (132° ± 5°C) for 2 hours.

3.6 Weigh and record the weight of the container and uncompacted hot mix to the nearest 0.1 gram.

3.7 Place the container and hot mix back in the oven and weigh at 1 hour intervals until constant weight is obtained. Constant weight for this test procedure is defined as when the material does not lose more than 0.05% of the original weight of the hot mix sample (obtained in 3.4 above) in a one hour period.

3.8 Once constant weight has been obtained, record the weight of the container, cover, and hot mix to the nearest 0.1 gram.

3.9 Subtract the final weight of the uncompacted hot mix, container, and cover from the original weight of the uncompacted hot mix, container and cover determined in 3.4 to determine the amount of moisture in the mix.

4. Report:

4.1 Calculate the moisture content in the mix to the nearest 0.1 percent. Report on form DOT-35.

$$\frac{A - B}{B} \quad X \quad 100$$

A = initial weight of uncompacted hot mix
B = final dry weight of uncompacted hot mix

5. References:

SD 312
SD 313
DOT-35

Moisture Sensitivity of Compacted Asphalt Concrete Paving Mixtures

1. Scope:

This test method covers the procedure for preparing and testing asphalt concrete specimens for the effect of water on the tensile strength of the paving mixture.

2. Apparatus:

2.1 Marshall slant foot rotating base compaction hammer.

2.2 Vacuum container, preferably a metal container and vacuum pump or water aspirator including a manometer or vacuum gauge.

2.3 Water bath at 140° ±2°F (60° ±1°C) and a water bath at 77° ±2°F (25° ±1°C).

2.4 Scale or Balance having the capacity to weigh any sample which may be tested utilizing this procedure and readable to the nearest 0.1 gram.

2.5 Loading jack or mechanical testing machine with a vertical motion rate of 2" (50.8 mm) per minute.

2.6 Steel loading strips with a concave surface having a radius of curvature equal to the nominal radius of the test specimen. The strips shall be 0.5" (12.7 mm) wide for 4" (101.6 mm) specimens and have a length that exceeds the thickness of the specimens.

2.7 Calipers capable of measuring to the nearest 0.01" (0.25 mm).

3. Procedure:

3.1 Preparation of Laboratory Specimens.

A. At least 8 specimens are prepared as described in the South Dakota Mix Design Procedure. When adding a dry powder additive such as lime to the material, use the same procedure to add lime as will be used in the field. If adding a liquid anti-stripping to the asphalt binder, add the required quantity of liquid anti-strip to the asphalt binder, mix with a mechanical mixing device for at least 3 minutes.

Maintain the asphalt binder at the mixing temperature until it is used. Two samples of the minimum size specified in SD 312 are to be

prepared to determine the theoretical maximum specific gravity of the uncompacted mix.

B. After mixing, the samples are put in a covered container in an oven at the compaction temperature for 2 hours prior to compaction.

C. The specimens shall be compacted to an air void level of 7% ±1% by adjusting the number of Marshall blows.

D. Cool the specimens until the mold can be handled without gloves and extract from the molds. Allow the specimens to set overnight and then proceed with the test procedure.

3.2 Preparation of Field Samples.

A. Obtain a random sample of mix from behind the paver screed.

B. Stabilize the mix at the compaction temperature for 1 hour in the lab.

C. Compact at least 8 specimens to 7% ±1% air void level using SD 313 test procedures.

D. Cool the specimens to room temperature and extract from the molds. Allow the specimens to set overnight and then proceed with the test procedure.

3.3 Preparation of Core Test Specimens.

A. Select the core locations by using a random number table. Obtain at least 8 cores for testing. Separate the core lifts by use of a cutoff saw.

B. When determining the dry weight, make sure no moisture is remaining in the core.

3.4 Procedure for Determining Subsets.

A. Determine the theoretical maximum specific gravity of the mixture by using SD 312.

B. Determine specimen thickness to the nearest .01" (0.25 mm) by using calipers to measure the thickness at four quarter point locations on the specimen.

C. Determine the bulk specific gravity of the specimens by using SD 313. Record the dry weight, the submersed weight, and the saturated surface dry weight on a DOT-48. The SSD weight minus the submersed weight is the volume of the specimen in cubic centimeters.

D. Calculate the air voids as shown in SD 313. (The theoretical maximum specific gravity minus the specimen bulk specific gravity divided by the theoretical maximum specific gravity times 100 will be the percent of air voids.) Record the air voids to the nearest 0.01 percent.

E. Sort specimens into two subsets of at least three specimens each, so that the average air voids of the two subsets are approximately equal. The 2 extra samples can be used to determine the correct amount of vacuum needed in the saturation procedure.

F. One subset will be tested dry and the other subset will be preconditioned before testing. The dry subset will be stored at room temperature until tested.

3.5 Procedure for Subset to be Saturated.
(Laboratory, Field or Core Specimens)

A. Partially saturate the subset to be moisture conditioned with room temperature distilled water using a vacuum container and a vacuum gauge or manometer to control the level of vacuum applied. Put one of the specimens in a vacuum container for 3 to 5 minutes with a specific level of vacuum applied such as 10" (254 mm) of Hg. After the vacuum saturation, place in 77° ±2°F (25° ±1°C) water for 3 to 3.5 minutes and then determine the submerged weight and the saturated surface dry weight of the partially saturated specimen. Determine the volume of water absorbed by subtracting the air dry mass of the specimen in 3.4 C. from the saturated surface dry mass obtained above. Continue to place in the vacuum container and reapply a higher level of vacuum until the specimen is saturated to the level required by this test procedure. If the level of saturation exceeds the upper limit allowed, the specimen is damaged and must be discarded.

B. If the average air voids of the subset to be saturated is 6.5% or less, saturate to a level of 70% to 80%. If the average air voids of the subset is between 6.6% and 7.4%, saturate to a level of 55% to 80%. If the average air voids of the subset is 7.5% or more, saturate to a level of 55% to 65%. One of the extra samples may be used to determine the correct amount of vacuum to apply to get the required level of saturation.

Remember, if the specimen is saturated to a level exceeding the upper limit, the specimen is damaged and must be discarded. The level of saturation is determined by dividing the volume of the absorbed water in 3.5 A. above by the volume of air voids in 3.4 D. and expressing as a percentage.

C. Moisture condition the partially saturated specimens by soaking in distilled water at 140° ±2°F (60° ±1°C) for 24 hours.

After the 24 hour period, remove the specimens and place them in a 77° ±2°F (25° ±1°C) water bath for one hour.

D. After one hour, measure the height of the moisture conditioned specimens to the nearest .01" (0.25 mm) and determine the saturated surface dry weight, the submersed weight and the difference which is the volume of the saturated specimen. Return the specimens to the 77° ±2°F (25° ±1°C) water bath until ready to determine the tensile strength.

E. Determine the water absorption and the degree of saturation. A degree of saturation exceeding 80% is acceptable at this stage in the testing procedure.

F. Determine the swell of the partially saturated subset by dividing the change in specimen volumes from 3.5 A. and 3.4 C. by the specimen volume in 3.4 C. Determine the swell of the moisture conditioned specimens by dividing the change in specimen volumes from 3.5 E. and 3.4 C. by the specimen volume in 3.4 C.

3.6 Procedure for Subset to be Tested Dry.

A. Adjust the temperature of the dry subset by soaking in a water bath for 20 minutes at 77° ±2°F (25° ±1°C).

3.7 Procedure for Determining the Tensile Strength.

A. Determine the tensile strength at 77° ±2°F (25° ±1°C) of both subsets.

B. Place a specimen in the loading strip apparatus and position the loading strips so that they are parallel and centered on the vertical diametral plane. Apply a diametral load at 2" (50.8 mm) per minute until the maximum load is reached, and record the maximum load on a DOT-48.

C. Continue loading until the specimen fractures. Break open the specimen and visually estimate the degree of moisture damage, if any.

D. Record observations on the degree of broken or cracked aggregate.

4. Report:

4.1 Calculate the tensile strength (S) as follows:

S = Tensile Strength, psi (kPa)

P = Maximum load, pounds (kilogram)

t = Specimen height immediately before tensile strength test, .01 inches (0.25 mm)

D = Specimen diameter, .01 inches (0.25 mm)

π = pi = 3.1416

$$S = \frac{(2*P)}{(\pi*t*D)}$$

TSR = Tensile Strength Ratio, percent

Stm = Average Tensile Strength of the moisture conditioned subset, psi (kPa)

Std = Average Tensile Strength of the dry subset, psi (kPa)

$$TSR = \frac{Stm}{Std} \times 100$$

4.2 Record the test data on a DOT-48. Weights shall be recorded to the nearest 0.1 gram. Bulk specific gravity's and maximum specific gravity's shall be recorded to the nearest thousandth. Load shall be recorded to the nearest pound.

4.3 Volume and percentage calculations shall be reported to the nearest 0.01.

4.4 Tensile Strength shall be calculated to the nearest 0.1 and the TSR reported to the nearest whole number.

5. References:

AASHTO T 245
ASTM D 4867
SD 312
SD 313
DOT-48
SD Mix Design Procedures

MOISTURE SENSITIVITY REPORT - ASPHALT CONCRETE SURFACING

DOT - 48Q
2-01

FILE NUMBER _____

PROJECT	P 3079(00)219
PCN	5415
COUNTY	Harding
DATE	6/27/2000
ASPHALT BINDER	Cenex PG 58-28
ADDITIVE & DOSAGE	0.75 percent hydrated lime
METHOD OF ADDING	dry to aggregate with 3% H_2O
COMPACTION BLOWS	13 blows per side

		Spec.'s
DESIGN LEVEL	Q LVT	
DESIGN AIR VOIDS	2.9	
DESIGN AC CONTENT	6.0	
AVERAGE AIR VOIDS	6.72	6-8
AVERAGE SATURATION LEVEL	65.0	55-80
TENSILE STRENGTH RATIO	82	> 60

SPECIMEN NUMBER		1	2	3	4	5	6	7	8	9	10
DIAMETER (.01 in.)	D	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
THICKNESS (.01 in.)	t	2.53	2.57	2.61	2.57	2.57	2.59	2.56	2.58	2.59	2.66
DRY MASS IN AIR (0.1 g)	A	1169.4	1154.7	1177.4	1173.9	1163.5	1167.5	1181.4	1168.0	1175.8	1200.7
MASS IN WATER (0.1 g)	B	650.5	641.5	650.0	654.5	648.5	642.8	663.9	648.1	652.3	662.4
SSD MASS (0.1 g)	C	1170.6	1157.3	1179.1	1175.7	1164.9	1169.4	1182.6	1169.5	1177.7	1201.9
VOLUME (C - B)	E	520.1	515.8	529.1	521.2	516.4	526.6	518.7	521.4	525.4	539.5
BULK SP. GR. (A / E)	F	2.248	2.239	2.225	2.252	2.253	2.217	2.278	2.240	2.238	2.226
THEO. MAX. SP. GR.	G	2.403	2.403	2.403	2.403	2.403	2.403	2.403	2.403	2.403	2.403
% AIR VOIDS ((G-F)/G)x100	H	6.45	6.82	7.41	6.28	6.24	7.74	5.20	6.78	6.87	7.37
VOLUME AIR VOIDS (HE)/100	I	33.55	35.18	39.21	32.73	32.22	40.76	26.97	35.35	36.09	39.76
LOAD (LB.)	P	1105	1235				1235			1270	

AVERAGE AIR VOIDS OF DRY SUBSET: 6.97

SATURATED: 3 MIN. 19 "HG

AVERAGE AIR VOIDS OF SAT. SUBSET: 6.96

MASS IN WATER (0.1 g)	B'			674.0	672.7				670.2		687.1
SSD MASS (0.1 g)	C'			1203.6	1194.0				1191.6		1226.6
VOLUME (C' - B')	E'			529.6	521.3				521.4		539.5
VOL. ABS. WATER (C' - A)	J'			26.2	20.1				23.6		25.9
% SATURATION (J'/ I) x 100				66.8	61.4				66.8		65.1
% SWELL ((E' -E) / E) x 100				0.09	0.02				0.00		0.00

CONDITIONED 24 HOURS IN 140 DEGREE F WATER

THICKNESS (.01 in.)	t"			2.61	2.58				2.59		2.66
MASS IN WATER (0.1 g)	B"			681.9	680.1				678.2		695.5
SSD MASS (0.1 g)	C"			1217.4	1205.8				1206.3		1242.6
VOLUME (C" - B")	E"			535.5	525.7				528.1		547.1
VOL. ABS. WATER (C" - A)	J"			40.0	31.9				38.3		41.9
% SATURATION (J" / I) x 100				102.0	97.5				108.4		105.4
% SWELL((E" - E) / E) x 100				1.21	0.86				1.29		1.41
LOAD (LB.)	P"			1000	1030				940		1035
DRY STRENGTH ((2P) / tD□)	Std	69.5	76.5				75.9			78.0	
WET STRENGTH((2P") / t"D□)	Stm			61.0	63.5				57.8		61.9
VISUAL MOISTURE DAMAGE											
CRACK / BREAK DAMAGE											

□ = 3.1416

TENSILE STRENGTH RATIO $\frac{\text{Average Wet Strength (psi)}}{\text{Average Dry Strength (psi)}}$ $\frac{\text{Stm1+ Stm2 + ...+ Stmn}}{\text{Std1 + Std2 + ... + Stdn}} = \frac{61.1}{75.0} \times 100 =$ **81.5**

mso.mat 9-05

Method of Test for Theoretical Maximum Specific Gravity of Asphalt Concrete Paving Mixtures

1. Scope:

This test is to determine the Theoretical Maximum Specific Gravity and/or Density of uncompacted asphalt concrete paving mixtures. The Theoretical Maximum Specific Gravity or Density is the Standard used in the determination of in-place density of asphalt concrete pavements.

2. Apparatus:

2.1 Scale or Balance having the capacity to weigh any sample which may be tested utilizing this procedure and readable to the nearest 0.1 gram. The scale or balance shall be equipped with a suitable suspension apparatus and holder to permit weighing the sample while suspended from the center of the scale pan of the weighing device.

2.2 Vacuum pycnometer capable of holding 3000 grams of loose asphalt mix.

2.3 Vacuum pump or water aspirator for evacuating air from the container. If a vacuum pump is used a suitable trap shall be installed between the pycnometer and the vacuum source.

2.4 Vibrating plate for continuously agitating the asphalt concrete mixture and container.

2.5 Water container that will provide a sufficient amount of potable water to maintain a uniform temperature throughout the testing procedure. An aquarium heater will work to control the temperature of water at 77° ± 2° F (25° ± 1° C).

2.6 A thermometer with subdivisions and maximum scale error of 1° F (0.5° C) to cover the range of testing.

2.7 A residual pressure manometer is required to measure the amount of vacuum.

2.8 A bleeder valve attached to the vacuum system to facilitate adjustment of the vacuum being applied to the vacuum container.

2.9 The water bath for immersing the sample if using the (Weighing in Water Method) shall be equipped with an overflow outlet for maintaining a constant water level. The water bath must be large enough to allow the suspension apparatus holder to be covered with water at all times. The

sample and suspension apparatus must be completely covered with water during weighing. The wire suspending the suspension apparatus shall be the smallest practical size to minimize any possible effects of a variable immersed length.

3. **Procedure:**

3.1 Sampling of Uncompacted Mix.

A. A random sample, approximately 70 to 80 lbs. (32 to 36 kg), of hot mix shall be taken from the paver area, **- 110 to 120 lbs. (50 to 55 kg), when IA testing is required**. Samples may be obtained from behind the paver screed or from the windrow in front of the pickup machine. Material from the same sample shall be used for both SD 312 and SD 313 test procedures. On projects not requiring QC/QA testing a minimum sample size of 35 to 40 lbs. is required.

Sampling from behind the paver screed.

EXAMPLE: Select a location in the random number table. Take that number (0.58) times the tonnage in the lot (1000). The sample will be taken at 580 tons into the lot on the road at the location the truck unloads where the weigh ticket is nearest to 580 tons. Record the weigh ticket number on the DOT 42Q. Use a 2nd random number (0.17) to select the distance from centerline where the sample will be taken. An example of this is 0.17 x 12' (3.7m) width = 2.0' (0.6m) from centerline.

Sample the mix by placing a template through the entire lift of hot mix or by using a square shovel to create a sample area with vertical faces. Remove all material within the template or between the vertical lifts and place in the sample container or containers. On QC/QA Projects obtain at least three approximately equal increments from this sample area for each sample container by placing the increments by alternating between sample container using a square bottom shovel or scoop. The QC/QA and IA sample splits can be obtained by using this procedure. The sample in each sample container must be large enough for two complete sets of all required tests. | 06

Sampling from the windrow in front of the pickup machine.

The random sample for QC/QA Projects shall be selected by using random numbers such as from the tables included in this test procedure. Use the random number selected to determine the tonnage location in the sublot where the sample will be obtained.

Do not sample the top surface of the windrow. Use a square bottom shovel to remove and discard the top foot of material from the windrow. Next, remove and discard the outside edge of the remaining windrow to create a vertical face parallel to the windrow. Obtain the sample from the exposed vertical face. Split samples can be obtained by alternating equal shovels of hot mix into the sample containers. The QC, QA and IA sample splits can be obtained by using this procedure. The sample in each sample container must be large enough for two complete sets of all required tests.

B. Samples shall not be obtained from the first 50 tons (45 mton) of hot mix at the beginning of the day's operation or immediately following a long delay or change in mix proportions. There will be a 200 ton buffer between the random locations of the hot mix samples.

C. Transport the sample in a pail or box that is insulated or protected to help retain heat.

3.2 Calibration of the Pycnometer for the weighing in air method.

A. Determine the weight of the container completely full of water with the calibration lid on, over the range of temperatures that will likely be encountered in service. Be sure the outside of the container is dry when weighed. Measure and record the temperature of the water and the weight of the container to the nearest 0.1 gram for at least one calibration point per 4° F (2° C) after allowing the water to be in the container for 15 minutes. Construct a calibration curve for the water and container that is being used so that the weight of the container filled with water can be determined for any temperature from the calibration curve. At least weekly check the weight of the container filled with water to verify the weight is very close to the same as obtained from the calibration curve. Record the checks in the field diary.

Correction Factor For Different Water Temperatures °F (°C)

°C	°F		°C	°F		°C	°F	
(15.6)	60	1.0020	(21.7)	71	1.0008	(27.2)	81	0.9994
(16.1)	61	1.0019	(22.2)	72	1.0007	(27.8)	82	0.9992
(16.7)	62	1.0018	(22.8)	73	1.0005	(28.3)	83	0.9991
(17.2)	63	1.0017	(23.3)	74	1.0004	(28.9)	84	0.9989
(17.8)	64	1.0016	(23.9)	75	1.0003	(29.4)	85	0.9988
(18.3)	65	1.0015	(24.4)	76	1.0001	(30.0)	86	0.9986
(18.9)	66	1.0014	(25.0)	77	1.0000	(30.6)	87	0.9984
(19.4)	67	1.0013	(25.6)	78	0.9999	(31.1)	88	0.9983
(20.0)	68	1.0012	(26.1)	79	0.9998	(31.7)	89	0.9981
(20.6)	69	1.0011	(26.7)	80	0.9996	(32.2)	90	0.9979
(21.1)	70	1.0009						

NOTE: Whenever possible, use water that is close to 77°F (25°C).

3.3 Sample Size and Preparation.

A. The size of the sample shall conform to the following requirements.

Nominal Maximum Size Of Aggregate	Minimum Size of Sample
1-1/4" (31.5 mm)	3 kg
1" (25.0 mm)	2.5 kg
¾" (19.0 mm)	2 kg
½" (12.5 mm)	1.5 kg
3/8" (9.5 mm)	1 kg
No. 4 (4.75 mm)	0.5 kg

B. Obtain 2 representative samples for testing from the sample taken in accordance with paragraph 3.1. Use the quartering method in SD 213, an asphalt quartering device, or by using the method as follows. Place the original sample in a large clean pan where there will be neither loss of material nor the addition of foreign matter. Mix the sample thoroughly and flatten the material in the pan. Obtain a representative cross section of the pan area by using a heated flat bottom scoop to obtain material for testing. Scoop material from several selected locations in the pan to achieve a sample size that will conform to the requirements in the sample size table 3.3 A.

C. Separate the particles of the sample on a clean surface, to prevent contamination. The fines portion of the hot mix shall be separated such that no lumps are larger than ¼" (6 mm). If the mixture is not sufficiently soft to be separated manually, place it in a large flat pan and warm in an oven until it can be handled.

D. Cool the sample to room temperature before beginning the test.

3.4 Determine the Theoretical Maximum Specific Gravity by one of the following methods.

(Weighing in Air Method)

A. Weigh the cooled sample to the nearest 0.1 gram in a tared container and record the weight. Add sufficient water to cover the sample approximately 1" (6 mm). The release of entrapped air may be facilitated by the addition of a suitable wetting agent such as AEROSOL OT in concentration of 0.001 percent or 0.2 grams in 20L of water. This solution is then diluted by about 20:1 to make a wetting agent of which 5 to 10 mL may be added to the container.

B. Remove entrapped air by subjecting the contents to a partial vacuum of 26 to 30 mm Hg. absolute pressure for 15 minutes ± 30 seconds. Agitate the container and contents continuously by a mechanical device. A mercury manometer shall be installed inline to measure the amount of vacuum applied. A bleeder valve shall be installed in the vacuum system to maintain the vacuum at the required level.

C. Upon completion of the 15 minute vacuum period, fill the container with water. Place a thermometer in the container and record the water temperature 9 minutes after completing the vacuum period. Replace the calibration lid, dry the outside of the container, and record the weight of the container, sample and water to the nearest 0.1 gram.

D. Repeat A., B., and C. for a duplicate sample. The values of the two samples will be averaged for final results.

E. Duplicate specific gravity values not within 0.011 should be considered suspect and performed again.

(Weighing in Water Method)

F. Weigh the cooled sample to the nearest 0.1 gram in a tared container and record the weight. Add sufficient water to cover the sample approximately 1" (6 mm). The release of entrapped air may be facilitated by the addition of a suitable wetting agent such as AEROSOL OT in concentration of 0.001 percent or 0.2 grams in 20L of water. This solution is then diluted by about 20:1 to make a wetting agent of which 5 to 10 mL may be added to the container.

G. Remove entrapped air by subjecting the contents to a partial vacuum of 26 to 30 mm Hg. absolute pressure for 15 minutes ± 30 seconds. Agitate the container and contents continuously by a mechanical device. A mercury manometer shall be installed inline to measure the amount of vacuum applied. A bleeder valve shall be installed in the vacuum system to maintain the vacuum at the required level.

H. Upon completion of the 15 minute vacuum period, suspend the container and material in the water bath for 9 minutes. Record the water temperature. Record the weight of the container and sample suspended under water to the nearest 0.1 gram. Maintain a constant level of water in the water bath with the use of an overflow outlet.

I. Weigh the empty container suspended under water and record the weight to the nearest 0.1 gram.

J. Repeat F., G., H., and I. for a duplicate sample. The values of the two samples will be averaged for final results.

K. Duplicate specific gravity values not within 0.011 should be considered suspect and performed again.

4. Report:

4.1 Calculate the Theoretical Maximum Specific Gravity of the asphalt concrete mix in one of the following manners: (Figure 1)

4.2

(Weighing in Air Method) (Figure 1)

Theoretical Maximum Specific Gravity = $[A / (A + B - C)] \times D$

A = Dry weight of the sample.

B = Calibration weight of the canister and water at the test temperature.

C = Final weight of the canister, water & sample.

D = Correction factor for water temperature.

(Weighing in Water Method) (Figure 2)

Theoretical Maximum Specific Gravity = [A / (A + B - C)] x D

A = Dry weight of the sample.

B = Weight of the canister suspended under water.

C = Weight of the canister and sample suspended under water.

D = Correction factor for water temperature.

Report the Theoretical Maximum Specific Gravity to the third decimal place.

4.3 Calculate the Standard Unit Weight in the following manner if required by the specifications:

Standard Unit Weight ($lb./ft^3$) = Theo. Maximum Specific Gravity x 62.245
Standard Unit Weight (kg/m^3) = Theo. Maximum Specific Gravity x 997.2

4.4 Report the Standard Unit Weight to one decimal place if required by the specifications.

5. References:

DOT-42
DOT-42Q

AIR VOIDS REPORT - ASPHALT CONCRETE SURFACING DOT 42QA

FILE NUMBER _____ 4-01

COUNTY	Any	PROJECT	P 0000(00)0			PCN	1234
SUBLOT NUMBER	QC-1	DATE	6/1/2000	TIME	10:05 AM	LIFT	2 of 2
SAMPLE OBTAINED FROM	behind paver screed	DISTANCE LT. OR RT. OF CENTERLINE					4' Left
TICKET NUMBER	123456	TONS	496	QUANTITY REPRESENTED (tons)			1000
SAMPLED BY	Jim Jones	TESTED BY	Jim Jones	CHECKED BY			RER
PERCENT BINDER DESIRED	6.4	DAILY BINDER CONTENT DETERMINATION (DOT 89)					6.3

THEORETICAL MAXIMUM SPECIFIC GRAVITY (RICE)

(Weighing in Air Method)	1	2	(Weighing in Water Method)
A. Weight of sample in air	2006.8	2009.1	A. Weight of sample in air
B. Weight of container + water	7442.7	7443.5	B. Weight of container under water
C. Weight of container + water + sample	8644.2	8647.4	C. Weight of container + sample under water
Temperature of the water ° F	77	74	Temperature of the water ° F
D. Water correction factor	1.0000	1.0004	D. Water correction factor
E. Theo. Maximum Specific Gravity [A / (A + B - C)] x D	2.492	2.496	E. Theo. Maximum Specific Gravity [A / (A + B - C)] x D
F. Average Theo. Maximum Specific Gravity	2.494		F. Average Theo. Maximum Specific Gravity

MARSHALL BULK SPECIFIC GRAVITY DATA

	specimen numbers		
A. Height of specimen			
B. Weight of specimen in air			
C. Weight of specimen in water			
D. Weight of SSD specimen in air			
E. Volume Displaced (D-C)			
F. Bulk Specific Gravity (B / E)			
G. Actual Compaction Temperature			
JMF Compaction Temp. _____			
H. Average Bulk Specific Gravity			

PERCENT AIR VOIDS CALCULATION

[(Maximum Sp. Gr. - Marsh. Bulk Sp. Gr.) / Maximum Sp. Gr.] x 100 = _____

Figure 1

AIR VOIDS REPORT - ASPHALT CONCRETE SURFACING DOT 42QA

FILE NUMBER _____ 4-01

COUNTY	Any	PROJECT	P 0000(00)0			PCN	1234
SUBLOT NUMBER	QC-1	DATE	6/1/2000	TIME	10:05 AM	LIFT	2 of 2
SAMPLE OBTAINED FROM	behind paver screed	DISTANCE LT. OR RT. OF CENTERLINE					4' Left
TICKET NUMBER	123456	TONS	496	QUANTITY REPRESENTED (tons)			1000
SAMPLED BY	Jim Jones	TESTED BY	Jim Jones	CHECKED BY			RER
PERCENT BINDER DESIRED	6.4	DAILY BINDER CONTENT DETERMINATION (DOT 89)					6.3

THEORETICAL MAXIMUM SPECIFIC GRAVITY (RICE)

(Weighing in Air Method)	1	2	(Weighing in Water Method)
A. Weight of sample in air	2006.8	2009.1	A. Weight of sample in air
B. Weight of container + water	1283.6	1283.1	B. Weight of container under water
C. Weight of container + water + sample	2485.0	2486.9	C. Weight of container + sample under water
Temperature of the water ° F	77	74	Temperature of the water ° F
D. Water correction factor	1.0000	1.0004	D. Water correction factor
E. Theo. Maximum Specific Gravity [A / (A + B - C)] x D	2.492	2.496	E. Theo. Maximum Specific Gravity [A / (A + B - C)] x D
F. Average Theo. Maximum Specific Gravity	2.494		F. Average Theo. Maximum Specific Gravity

MARSHALL BULK SPECIFIC GRAVITY DATA

	specimen numbers		
A. Height of specimen			
B. Weight of specimen in air			
C. Weight of specimen in water			
D. Weight of SSD specimen in air			
E. Volume Displaced (D-C)			
F. Bulk Specific Gravity (B / E)			
G. Actual Compaction Temperature			
JMF Compaction Temp. _____			
H. Average Bulk Specific Gravity			

PERCENT AIR VOIDS CALCULATION

[(Maximum Sp. Gr. - Marsh. Bulk Sp. Gr.) / Maximum Sp. Gr.] x 100 = _____

Figure 2

SDDOT
TABLE OF RANDOM NUMBERS

.53 .74 .23 .99 .67	.61 .32 .28 .69 .84	.94 .62 .67 .86 .24	.98 .33 .74 .19 .95	.47 .53 .53 .38 .09
.63 .38 .06 .86 .54	.99 .00 .65 .26 .94	.02 .82 .90 .23 .07	.79 .62 .67 .80 .60	.75 .91 .12 .81 .19
.35 .30 .58 .21 .46	.06 .72 .17 .10 .94	.25 .21 .31 .75 .96	.49 .28 .24 .00 .49	.55 .65 .79 .78 .07
.63 .43 .36 .82 .69	.65 .51 .18 .37 .88	.61 .38 .44 .12 .45	.32 .92 .85 .88 .65	.54 .34 .81 .85 .35
.98 .25 .37 .55 .26	.01 .91 .82 .81 .46	.74 .71 .12 .94 .97	.24 .02 .71 .37 .07	.03 .92 .18 .66 .75
.02 .63 .21 .17 .69	.71 .50 .80 .89 .56	.38 .15 .70 .11 .48	.43 .40 .45 .86 .98	.00 .83 .26 .91 .03
.64 .55 .22 .21 .82	.48 .22 .28 .06 .00	.61 .54 .13 .43 .91	.82 .78 .12 .23 .29	.06 .66 .24 .12 .27
.85 .07 .26 .13 .89	.01 .10 .07 .82 .04	.59 .63 .69 .36 .03	.69 .11 .15 .83 .80	.13 .29 .54 .19 .28
.58 .54 .16 .24 .15	.51 .54 .44 .82 .00	.62 .61 .65 .04 .69	.38 .18 .65 .18 .97	.85 .72 .13 .49 .21
.34 .85 .27 .84 .87	.61 .48 .64 .56 .26	.90 .18 .48 .13 .26	.37 .70 .15 .42 .57	.65 .65 .80 .39 .07
.03 .92 .18 .27 .46	.57 .99 .16 .96 .56	.30 .33 .72 .85 .22	.84 .64 .38 .56 .98	.99 .01 .30 .98 .64
.62 .95 .30 .27 .59	.37 .75 .41 .66 .48	.86 .97 .80 .61 .45	.23 .53 .04 .01 .63	.45 .76 .08 .64 .27
.08 .45 .93 .15 .22	.60 .21 .75 .46 .91	.98 .77 .27 .85 .42	.28 .88 .61 .08 .84	.69 .62 .03 .42 .73
.07 .08 .55 .18 .40	.45 .44 .75 .13 .90	.24 .94 .96 .61 .02	.57 .55 .66 .83 .15	.73 .42 .37 .11 .16
.01 .85 .89 .95 .66	.51 .10 .19 .34 .88	.15 .84 .97 .19 .75	.12 .76 .39 .43 .78	.64 .63 .91 .08 .25
.72 .84 .71 .14 .35	.19 .11 .58 .49 .26	.50 .11 .17 .17 .76	.86 .31 .57 .20 .18	.95 .60 .78 .46 .75
.88 .78 .28 .16 .84	.13 .52 .53 .94 .53	.75 .45 .69 .30 .96	.73 .89 .65 .70 .31	.99 .17 .43 .48 .76
.45 .17 .75 .65 .57	.28 .40 .19 .72 .12	.25 .12 .74 .75 .67	.60 .40 .60 .81 .19	.24 .62 .01 .61 .16
.96 .76 .28 .12 .54	.22 .01 .11 .94 .25	.71 .96 .16 .16 .88	.68 .64 .36 .74 .45	.19 .59 .50 .88 .92
.43 .31 .67 .72 .30	.24 .02 .94 .08 .63	.38 .32 .36 .66 .02	.69 .36 .38 .25 .39	.48 .03 .45 .15 .22
.50 .44 .66 .44 .21	.66 .06 .58 .05 .62	.68 .15 .54 .35 .02	.42 .35 .48 .96 .32	.14 .52 .41 .52 .48
.22 .55 .22 .15 .86	.26 .63 .75 .41 .99	.58 .42 .36 .72 .24	.58 .37 .52 .18 .51	.03 .37 .18 .39 .11
.96 .24 .40 .14 .51	.23 .22 .30 .88 .57	.95 .67 .47 .29 .83	.94 .69 .40 .06 .07	.18 .16 .36 .78 .86
.31 .73 .91 .61 .19	.60 .20 .72 .93 .48	.98 .57 .07 .23 .69	.65 .95 .39 .69 .58	.56 .80 .30 .19 .44
.78 .60 .73 .99 .34	.43 .89 .94 .36 .45	.56 .69 .47 .07 .41	.90 .22 .91 .07 .12	.78 .35 .34 .08 .72
.84 .37 .90 .61 .56	.70 .10 .23 .98 .05	.85 .11 .34 .76 .60	.76 .48 .45 .34 .60	.01 .64 .18 .39 .96
.36 .67 .10 .08 .23	.98 .93 .35 .08 .86	.99 .29 .76 .29 .81	.33 .34 .91 .58 .93	.63 .14 .52 .32 .52
.07 .28 .59 .07 .48	.89 .64 .58 .89 .75	.83 .85 .62 .27 .89	.30 .14 .78 .56 .27	.86 .63 .59 .80 .02
.10 .15 .83 .87 .60	.79 .24 .31 .66 .56	.21 .48 .24 .06 .93	.91 .98 .94 .05 .49	.01 .47 .59 .38 .00
.55 .19 .68 .97 .65	.03 .73 .52 .16 .56	.00 .53 .55 .90 .27	.33 .42 .29 .38 .87	.22 .13 .88 .83 .34
.53 .81 .29 .13 .39	.35 .01 .20 .71 .34	.62 .33 .74 .82 .14	.53 .73 .19 .09 .03	.56 .54 .29 .56 .93
.51 .86 .32 .68 .92	.33 .98 .74 .66 .99	.40 .14 .71 .94 .58	.45 .94 .19 .38 .81	.14 .44 .99 .81 .07
.35 .91 .70 .29 .13	.80 .03 .54 .07 .27	.96 .94 .78 .32 .66	.50 .95 .52 .74 .33	.13 .80 .55 .62 .54
.37 .71 .67 .95 .13	.20 .02 .44 .95 .94	.64 .85 .04 .05 .72	.01 .32 .90 .76 .14	.53 .89 .74 .60 .41
.93 .66 .13 .83 .27	.92 .79 .64 .64 .72	.28 .54 .96 .53 .84	.48 .14 .52 .98 .94	.56 .07 .93 .89 .30
.02 .96 .08 .45 .65	.13 .05 .00 .41 .84	.93 .07 .54 .72 .59	.21 .45 .57 .09 .77	.19 .48 .56 .27 .44
.49 .83 .43 .48 .35	.82 .88 .33 .69 .96	.72 .36 .04 .19 .76	.47 .45 .15 .18 .60	.82 .11 .08 .95 .97
.84 .60 .71 .62 .46	.40 .80 .81 .30 .37	.34 .39 .23 .05 .38	.25 .15 .35 .71 .30	.88 .12 .57 .21 .77
.18 .17 .30 .88 .71	.44 .91 .14 .88 .47	.89 .23 .30 .63 .15	.56 .34 .20 .47 .89	.99 .82 .93 .24 .98
.79 .69 .10 .61 .78	.71 .32 .76 .95 .62	.87 .00 .22 .58 40	.92 .54 .01 .75 .25	.43 .11 .71 .99 .31
.75 .93 .36 .57 .83	.56 .20 .14 .82 .11	.74 .21 .97 .90 .65	.96 .42 .68 .63 .86	.74 .54 .13 .26 .94
.38 .30 .92 .29 .03	.06 .28 .81 .39 .38	.62 .25 .06 .84 .63	.61 .29 .08 .93 .67	.04 .32 .92 .08 .09
.51 .28 .50 .10 .34	.31 .57 .75 .95 .80	.51 .97 .02 .74 .77	.76 .15 .48 .49 .44	.18 .55 .63 .77 .09
.21 .31 .38 .86 .24	.37 .79 .81 .53 .74	.73 .24 .16 .10 .33	.52 .83 .90 .94 .76	.70 .47 .14 .54 .36
.29 .01 .23 .87 .88	.58 .02 .39 .37 .67	.42 .10 .14 .20 .92	.16 .55 .23 .42 .45	.54 .96 .09 .11 .06
.95 .33 .95 .22 .00	.18 .74 .72 .00 .18	.38 .79 .58 .69 .32	.81 .76 .80 .26 .92	.82 .80 .84 .25 .39
.90 .84 .60 .79 .80	.24 .36 .59 .87 .38	.82 .07 .53 .89 .35	.96 .35 .23 .79 .18	.05 .98 .90 .07 .35
.46 .40 .62 .98 .82	.54 .97 .20 .56 .95	.15 .74 .80[illegible].08 .32	.16 .46 .70 .50 .80	.67 .72 .16 .42 .79
.20 .31 .89 .03 .43	.38 .46 .82 .68 .72	.32 .14 .82 .99 .70	.80 .60 .47 .18 .97	.63 .49 .30 .21 .30
.71 .59 .73 .05 .50	.08 .22 .23 .71 .77	.91 .01 .93 .20 .49	.82 .96 .59 .26 .94	.66 .39 .67 .98 .60

Figure 3

Method of Test for Density and Air Voids of Asphalt Concrete by the Marshall Method

1. Scope:

This test is to determine the density and air void level of asphalt concrete mixtures.

2. Apparatus:

2.1 Slant foot (1° bevel) rotating base Marshall mechanical compaction machine mounted on a wooden pedestal secured to a concrete slab.

2.2 Compaction hammer conforming to AASHTO T 245.

2.3 Compaction molds conforming to AASHTO T 245.

2.4 Scale or Balance having the capacity to weigh any sample which may be tested utilizing this procedure and readable to the nearest 0.1 Gram. The scale or balance shall be equipped with a suitable suspension apparatus and holder to permit weighing the sample while suspended from the center of the scale pan of the weighing device.

2.5 Thermometers, dial type, armored glass, or digital with a range of 50° to 400°F (10° to 204°C) with a sensitivity of 5° F (2.8° C).

2.6 Thermometer sensitive to 0.5°F (0.2°C) and readable to 1°F (0.5°C).

2.7 Miscellaneous. Insulated gloves, small trowel, filter paper discs, pails, shovel, pans, scoop or spoon, fuel oil, and rags.

2.8 Electric hot plate or roaster oven.

2.9 Water bath with an overflow outlet for maintaining a constant water level. An aquarium heater will suffice to control the temperature of the water bath at 77° ± 2°F (25° ± 1°C). The water bath must be large enough to allow the suspension apparatus holder to be covered with water at all times. The sample and suspension apparatus must be completely covered with water during weighing. The wire suspending the suspension apparatus shall be the smallest practical size to minimize any possible effects of a variable immersed length.

2.10 A mechanical convection oven with a minimum chamber volume of 5.0 cubic feet (0.142 cubic meter) capable of heating to 350°F (177°C).

3. Procedure:

3.1 Sampling Uncompacted Mix.

A. Material for the Marshall determinations shall be obtained from the same sample as obtained in SD 312.

B. Take approximately 70 to 80 lbs. (32 to 36 kg) of hot mix for the laboratory density determination - **110 to 120 lbs. (50 to 55 kg) when IA testing is required.**

C. Transport the sample in a pail or box that is insulated or protected to help retain heat.

D. Place the sample in a clean pan where there will be neither loss of material nor the addition of foreign matter. Place the pan and material in an oven maintained at or slightly above the required compaction temperature.

3.2 Laboratory Density Determination.

A. Preheat 3 molds, a flat bottom scoop, and a trowel or spatula in an oven or on a hot plate to the established mix compaction temperature recommended on the job mix formula. Preheat the tamping face of the hammer to 200° to 300° F (93° to 149° C) on a hot plate. On non QC/QA Projects compact the mix at the delivery temperature to the road ±10°F (±6°C).

B. Obtain by quartering or by using a heated flat bottom scoop a representative sample, from the same pan of material used in SD 312 Section 3.3 B. The material placed in the mold shall make a Marshall specimen with a compacted height of 2 1/2" ± 1/8" (63.5 ±mm). Once the amount of material needed to make a compacted specimen the required height is established, material can be weighed into the compaction molds that have a paper disc in the bottom of the mold and placed in an oven. Monitor the temperature of the hot mix so that compacting will take place when the mix is at the established mix design compaction temperature recommended on the job mix formula. Thermometers should be calibrated and checked often to insure accurate temperature measurements.

C. Once the hot mix in the mold has reached the correct temperature, remove from the oven, rod 25 times (15 around the perimeter and 10 in the center) with the small trowel or spatula. After rodding, round off the top surface of the mixture. Measure and record the temperature of the mix in the mold.

D. Place a paper disc on the top of the mix in the mold and place the mold on the base of the mechanical compactor under the mold holder. Place the face of the hammer inside the mold and apply 50 blows, unless otherwise specified in the plans. Invert the mold and apply 50 blows or the number of blows specified in the plans to the opposite end of the specimen. After compaction, the base plate shall be removed and the paper discs discarded.

E. Repeat the procedure listed in paragraphs B., C., and D. above for the second and third specimens.

F. Cool the specimens in air. A fan may be used to aid in the cooling of the specimens. After a specimen has cooled enough to touch with the bare hand, remove it from the forming mold.

G. After removal, number each specimen and set aside. Avoid fracturing or deforming the specimens when handling. Rest specimens on a smooth, level surface until ready for testing. The height of each specimen shall be 2 1/2" ± 1/8" (63.5 ± 3 mm).

If the Marshall specimen doesn't compact to a height of 2 1/2" ± 1/8" (63.5 ± 3 mm), use the following equation to correct the amount of material to be used:

$$\frac{(2.5 \times A)}{B}$$

A = Actual weight of the specimen

B = Actual height of the specimen

H. After the specimen has cooled to room temperature, measure the height at four locations. Record the average height of the specimen to the nearest 1/16" (2 mm).

I. Weigh the specimen in air and record the weight to the nearest 0.1 gram.

J. Suspend the specimen in a water bath at 77° ± 2° F (25° ± 1° C) for 3 to 3.5 minutes. Record the immersed weight to the nearest 0.1 gram. Maintain a constant level of water in the water bath at the overflow outlet through the entire test procedure. 06

K. Immediately after weighing under water, blot the specimen dry with a damp terry cloth towel and record the saturated surface dry weight to the nearest 0.1 gram.

L. Repeat H., I., J., and K. for the other two specimens.

NOTE: Cores and pucks shall be weighed individually.

4. **Report:**

4.1 Calculate the Marshall Bulk Specific Gravity of the laboratory specimens in the following manner.

Marshall Bulk Specific Gravity

$$\frac{B}{D-C}$$

B= Weight of sample in air.

C = Weight of the sample suspended in water.

D = Weight of saturated surface dry sample in air.

4.2 Report the Marshall Bulk Specific Gravity to the nearest 0.001 on a DOT-42QA. [Figure 1]

Note: Use all three of the specimens provided the difference between the high and low specimen does not exceed 0.020. When any specimen varies by more than 0.020 from any of the other specimens, that specimen will not be used in the calculations and will be discarded. If the remaining two specimens are within 0.010 of each other, use their average for the Marshall density data. If they are not, discard the specimens and obtain a new set of Marshall specimens.

4.3 Calculate the percent of air voids in the following manner:

% Air Voids =

$$\frac{(E-F)}{E} \times 100$$

E = Theoretical Maximum Specific Gravity from SD 312

F = Marshall Bulk Specific Gravity average.

4.4 Report the percent air voids to the nearest 0.1 on a DOT-42QA.

5. **References:**

AASHTO T 245
DOT-42QA
SD 312

AIR VOIDS REPORT - ASPHALT CONCRETE SURFACING DOT 42QA

FILE NUMBER 4-01

COUNTY	Any	PROJECT	P 0000(00)0		PCN	1234	
SUBLOT NUMBER	QC-1	DATE	6/1/2000	TIME	10:05 AM	LIFT	2 of 2
SAMPLE OBTAINED FROM	behind paver screed	DISTANCE LT. OR RT. OF CENTERLINE					4' Left
TICKET NUMBER	123456	TONS	496	QUANTITY REPRESENTED (tons)			1000
SAMPLED BY	Jim Jones	TESTED BY	Jim Jones	CHECKED BY			RER
PERCENT BINDER DESIRED	6.4	DAILY BINDER CONTENT DETERMINATION (DOT 89)					6.3

THEORETICAL MAXIMUM SPECIFIC GRAVITY (RICE)

(Weighing in Air Method)	1	2
A. Weight of sample in air	2006.8	2009.1
B. Weight of container + water	7442.7	7443.5
C. Weight of container + water + sample	8644.2	8647.4
Temperature of the water ° F	77	74
D. Water correction factor	1.0000	1.0004
E. Theo. Maximum Specific Gravity [A / (A + B - C)] x D	2.492	2.496
F. Average Theo. Maximum Specific Gravity	2.494	

MARSHALL BULK SPECIFIC GRAVITY DATA

	specimen numbers 1A	1B	1C
A. Height of specimen	2.62	2.61	2.56
B. Weight of specimen in air	1243.7	1245.1	1236.4
C. Weight of specimen in water	722.1	724.3	718.7
D. Weight of SSD specimen in air	1245.1	1247.1	1237.6
E. Volume Displaced (D-C)	523.0	522.8	518.9
F. Bulk Specific Gravity (B / E)	2.378	2.382	2.383
G. Actual Compaction Temperature ° F	272	275	270
JMF Compaction Temp. 270 ° F			
H. Average Bulk Specific Gravity		2.381	

PERCENT AIR VOIDS CALCULATION

[(Maximum Sp. Gr. - Marsh. Bulk Sp. Gr.) / Maximum Sp. Gr.] x 100 = 4.5%

Figure 1

Method for Field Determination of the Daily Asphalt Binder Content

1. Scope:

This test covers the procedure for calculating the daily asphalt binder content for an asphalt hot mix plant.

2. Apparatus:

2.1 Furnished charts showing the capacity per fractions of an inch (mm) for each oil storage tank.

2.2 A measuring device to measure the amount of asphalt in the storage tank. A calibrated stick or tape measure.

NOTE: The asphalt storage tanks must be level and remain level for measurements to be reliable.

3. Procedure:

3.1 Measure the depth and take the temperature of the asphalt binder in the storage tank or tanks before the plant starts to produce hot mix.

3.2 Determine the number of gallons (L) of asphalt binder at the storage temperature from the charts furnished for the storage tank capacity. Convert this gallon (L) quantity to a weight quantity in pounds (kg) by using one of the formulas on the back of form DOT-89. (Figure 1) These formulas are used to determine the weight per gallon (L) of asphalt binder at a particular temperature by using a multiplier for correcting oil volumes to the basis of 60° F (15.6° C). Multiply the weight per gallon (L) of asphalt binder at the storage temperature by the number of gallons (L) and divide by 2,000 [illegible]. ([illegible]) to get the tons (Mtons) of asphalt binder in the storage tank. 06

The weight per gallon of asphalt binder at 60° F (15.6° C) and/or the specific gravity of the asphalt binder can be found on the Certificate of Compliance or weight ticket furnished with each load of asphalt binder delivered to the project.

3.3 Add up the weight in tons (Mtons) of the truckloads of asphalt binder added to the storage tanks during the day.

3.4 Measure the depth and take the temperature of the asphalt binder in the storage tank or tanks after the plant finishes producing hot mix.

3.5 Convert the gallons (L) of asphalt binder to tons (Mtons) by using the same procedure as used in 3.2 above.

3.6 Record the weight of all hot mix produced by the plant in tons (Mtons).

4. Report:

4.1 Calculate the Daily Asphalt Binder Content in the following manner to the nearest 0.01% on a DOT-89.

$$\text{Daily Asphalt Binder Content} = \frac{(A + B - C) \times 100}{D}$$

A = Tons (Mtons) of asphalt binder in the storage tanks at the start of the day.

B = Tons (Mtons) of asphalt binder added to storage tanks during the day.

C = Tons (Mtons) of asphalt binder in the storage tanks at the end of the day.

D = Tons (Mtons) of hot mix produced during the day.

4.2 Report the Daily Asphalt Binder Content to one decimal place.

5. References:

DOT-89

ASPHALT BINDER CONTENT DETERMINATION

DOT-89
4-01

File # _____ REPORT NO. 1

COUNTY Any PROJECT P 0000(00)0 PCN 1234

DATE 7/01/00 INSPECTOR Jim Jones CONTRACTOR ABC Corp.

Per Cent Binder Desired 6.1 Per Cent Used by Test 6.0 %

TANK METHOD

A.	Specific Gravity of Binder @ 60°F	1.013
B.	Weight Per Gallon of Binder @ 60°F	8.435
C.	Temperature of Binder in Tank When Check Starts° F	295
	TEMPERATURE CORRECTION FACTOR	0.9204
D.	Weight Per Gallon of Binder at Temperature	7.764
E.	Gallons in Tank When Check Starts (calibrated stick)	1050
F.	Weight of Binder in Tank (start check)(D x E/2000)	4.08
G.	Weight of Binder Added to Tank	121.16
H.	Temperature of Binder in Tank When Check Ends ° F	305
	TEMPERATURE CORRECTION FACTOR	0.9171
I.	Gallons In Tank When Check Ends (calibrated stick)	2620
J.	Weight Per Gallon of Binder at Temperature	7.736
K.	Weight of Binder in Tank (end check) (I x J/2000)	10.13
L.	Weight of Binder Used (F + G - K)	115.11
M.	Weight of Mix Produced (Tons)	1909.14
N.	Percent of Binder in Mix (L / M) x 100	6.03

G.

Load #	Invoice#	Tons
1	10007	23.00
2	10009	24.06
3	10012	24.45
4	10017	23.61
5	10019	26.04
		121.16

Summary of Mix Produced

To Road 1828.12 Tons

Plant Waste 1.62 Tons

To Others 79.40 Tons

Produced 1909.14 Tons

REMARKS: _____

Figure 1

DOT-89
(1-01)

DETERMINING POUNDS OF BITUMEN PER GALLON

1. _____ X _____ = X 8.328 (1) = _____ lbs. (kg) of Bitumen per Gallon (L) @ temperature
   Spec. Gravity of Bitumen — Temp. Factor

2. 8.435 X 0.9204 = 7.764 lbs. (kg) of Bitumen per Gallon (L) @ temperature
   Wt./Gal. (L) @ 60^0 F — Temp. Factor

Temp. ^{0}C	Temp. ^{0}F	Factor
107	225	0.9436
110	230	0.9419
113	235	0.9402
116	240	0.9385
118	245	0.9369
121	250	0.9352
124	255	0.9336
127	260	0.9319
129	265	0.9302
132	270	0.9286
135	275	0.9269
138	280	0.9253
141	285	0.9236
143	290	0.9220
146	295	0.9204
149	300	0.9187
152	305	0.9171
154	310	0.9154
157	315	0.9138
160	320	0.9122
163	325	0.9105
166	330	0.9089
168	335	0.9073
171	340	0.9057
174	345	0.9040
177	350	0.9024

Figure 1A

ASPHALT BINDER SPOT CHECK DETERMINATION

DOT-66
4-01

File # _____ REPORT NO. 1

COUNTY Any PROJECT P 0000(00)0 PCN 1234

DATE 7/01/00 INSPECTOR Jim Jones CONTRACTOR ABC Corp.

Per Cent Binder Desired 6.1 Per Cent Used by Test 6.2 %

TANK METHOD

A.	Specific Gravity of Binder @ 60°F	1.013
B.	Weight Per Gallon of Binder @ 60°F	8.435
C.	Temperature of Binder in Tank When Check Starts ° F	295
	TEMPERATURE CORRECTION FACTOR	0.9204
D.	Weight Per Gallon of Binder at Temperature	7.764
E.	Gallons in Tank When Check Starts (calibrated stick)	1050
F.	Weight of Binder in Tank (start check)(D x E/2000)	4.08
G.	Weight of Binder Added to Tank	47.06
H.	Temperature of Binder in Tank When Check Ends ° F	295
	TEMPERATURE CORRECTION FACTOR	0.9204
I.	Gallons in Tank When Check Ends (calibrated stick)	150
J.	Weight Per Gallon of Binder at Temperature	7.764
K.	Weight of Binder in Tank (end check) (I x J/2000)	0.58
L.	Weight of Binder Used (F + G - K)	50.56
M.	Weight of mix Produced (Tons)	810.50
N.	Percent of Binder in Mix (L / M) x 100	6.24

METER METHOD

		Non Compensating	Temperature Compensating
O.	Specific Gravity of Binder @ 60°F		
P.	Weight Per Gallon of Binder @ 60°F		
Q.	Temperature of Binder during Check ° F		
R.	TEMPERATURE CORRECTION FACTOR		
S.	Weight Per Gallon of Binder at Temperature		
T.	Meter reading in gallons when check starts		
U.	Meter reading in gallons when check ends		
V.	Gallons of binder used during check		
W.	Weight of Binder Used in tons (V x P or S)		
X.	Weight of mix Produced (Tons)		
Y.	Percent of Binder in Mix (W /X) x 100		

Figure 2

ASPHALT BINDER SPOT CHECK DETERMINATION

DOT-66
4-01

File # _____ REPORT NO. 1

COUNTY Any PROJECT P 0000(00)0 PCN 1234

DATE 7/01/00 INSPECTOR Jim Jones CONTRACTOR ABC Corp.

Per Cent Binder Desired 6.1 Per Cent Used by Test 6.2 %

TANK METHOD

A.	Specific Gravity of Binder @ 60°F	
B.	Weight Per Gallon of Binder @ 60°F	
C.	Temperature of Binder in Tank When Check Starts ° F	
	TEMPERATURE CORRECTION FACTOR	
D.	Weight Per Gallon of Binder at Temperature	
E.	Gallons in Tank When Check Starts (calibrated stick)	
F.	Weight of Binder in Tank (start check)(D x E/2000)	
G.	Weight of Binder Added to Tank	
H.	Temperature of Binder in Tank When Check Ends ° F	
	TEMPERATURE CORRECTION FACTOR	
I.	Gallons in Tank When Check Ends (calibrated stick)	
J.	Weight Per Gallon of Binder at Temperature	
K.	Weight of Binder in Tank (end check) (I x J/2000)	
L.	Weight of Binder Used (F + G - K)	
M.	Weight of mix Produced (Tons)	
N.	Percent of Binder in Mix (L / M) x 100	

METER METHOD

		Non Compensating	Temperature Compensating
O.	Specific Gravity of Binder @ 60°F	1.013	
P.	Weight Per Gallon of Binder @ 60°F	8.435	
Q.	Temperature of Binder during Check ° F	295	
R.	TEMPERATURE CORRECTION FACTOR	0.9204	
S.	Weight Per Gallon of Binder at Temperature	7.764	
T.	Meter reading in gallons when check starts	45658	
U.	Meter reading in gallons when check ends	58340	
V.	Gallons of binder used during check	12682	
W.	Weight of Binder Used in tons (V x P or S)	49.23	
X.	Weight of mix Produced (Tons)	790.05	
Y.	Percent of Binder in Mix (W /X) x 100	6.23	

Figure 3

ASPHALT BINDER SPOT CHECK DETERMINATION

DOT-66
4-01

File # _____ REPORT NO. 1

COUNTY Any PROJECT P 0000(00)0 PCN 1234

DATE 7/01/00 INSPECTOR Jim Jones CONTRACTOR ABC Corp.

Per Cent Binder Desired 6.1 Per Cent Used by Test 6.2 %

TANK METHOD

A.	Specific Gravity of Binder @ 60°F	
B.	Weight Per Gallon of Binder @ 60°F	
C.	Temperature of Binder in Tank When Check Starts ° F	
	TEMPERATURE CORRECTION FACTOR	
D.	Weight Per Gallon of Binder at Temperature	
E.	Gallons in Tank When Check Starts (calibrated stick)	
F.	Weight of Binder in Tank (start check)(D x E/2000)	
G.	Weight of Binder Added to Tank	
H.	Temperature of Binder in Tank When Check Ends ° F	
	TEMPERATURE CORRECTION FACTOR	
I.	Gallons in Tank When Check Ends (calibrated stick)	
J.	Weight Per Gallon of Binder at Temperature	
K.	Weight of Binder in Tank (end check) (I x J/2000)	
L.	Weight of Binder Used (F + G - K)	
M.	Weight of mix Produced (Tons)	
N.	Percent of Binder in Mix (L / M) x 100	

METER METHOD

		Non Compensating	Temperature Compensating
O.	Specific Gravity of Binder @ 60°F		1.013
P.	Weight Per Gallon of Binder @ 60°F		8.435
Q.	Temperature of Binder during Check ° F		
R.	TEMPERATURE CORRECTION FACTOR		
S.	Weight Per Gallon of Binder at Temperature		
T.	Meter reading in gallons when check starts		45658
U.	Meter reading in gallons when check ends		57335
V.	Gallons of binder used during check		11677
W.	Weight of Binder Used in tons (V x P or S)		49.25
X.	Weight of mix Produced (Tons)		790.05
Y.	Percent of Binder in Mix (W /X) x 100		6.23

Figure 4

Field Density Determination of Asphalt Concrete By the Coring Method

1. Scope:

This procedure is for determining the density of in place asphalt concrete pavement.

2. Apparatus:

2.1 Scale or Balance having the capacity to weigh any sample which may be tested utilizing this procedure and readable to the nearest 0.1 Gram. The scale or balance shall be equipped with a suitable suspension apparatus and holder to permit weighing the sample while suspended from the center of the scale pan of the weighing device.

2.2 Coring device capable of getting a minimum 4" (100 mm) diameter core from the pavement.

2.3 Diamond tipped blade cut off saw capable of sawing the 4" (100 mm) or larger core on the correct lift line without distortion and damage to the core.

2.4 The water bath for immersing the sample shall be equipped with an overflow outlet for maintaining a constant water level. An aquarium heater will suffice to control the temperature of the water bath at 77° ±2° F (25° ±1° C). The water bath must be large enough to allow the suspension apparatus holder to be covered with water at all times. The sample and suspension apparatus must be completely covered with water during weighing. The wire suspending the suspension apparatus shall be the smallest practical size to minimize any possible effects of a variable immersed length.

3. Procedure:

3.1 Randomly select 2 core sites per 1000 ton sublot and mark for the Contractor to core. Adjust the random core locations falling within one foot (0.3 m) of the pavement edge to one foot (0.3 m) from the pavement edge. Exercise care when removing the core from the pavement to prevent distortion or cracking. Label the core sample.

3.2 After removing the core, fill the hole in the pavement before the end of the next working day with mix and tamp to a density, which will be close to that of the surrounding pavement.

3.3 Transport the cores to the field laboratory site. Measure the core lift or lifts to the nearest .05 inch or 1/16" (1 mm) and record the measurements on a core dry back worksheet (DOT-8). Remove the pavement lift of interest from the core by using a cut off or masonry saw with a diamond tipped blade. Inspect the core for damage. Record the sawed core thickness on line (A) of the core dry back worksheet (DOT-8).

3.4 Weigh the core and record the **apparent dry weight** to the nearest 0.1 gram on line (B).

NOTE: Cores and pucks shall be weighed individually.

3.5 Immerse each core in water at 77° ±2° F (25° ±1° C) for 3 to 3.5 minutes and record the submersed weight to the nearest 0.1 gram on line (C). **Maintain a constant level of water in the water bath by the overflow outlet** through the end of each procedure. 06

3.6 Remove each core from the water and surface dry by blotting with a damp terry cloth towel and record the surface-dry mass to the nearest 0.1 gram on line (D).

3.7 Calculate the volume of the core (D-C). Record on line (E).

NOTE: Cores have taken on water from the coring and sawing process. The following procedure must be used to get the water out of the cores. Dry each core to a constant weight by drying in an oven to determine the actual core dry weight. Constant weight is defined as when drying at 230° ± 9° F (110° ± 5° C) does not alter the apparent dry weight by more than 0.1 percent when weighed at the initial 2 hour interval and then at 1 hour intervals thereafter. 06

3.8 Record the pan number on line (F).

3.9 Record the weight of the pan to the nearest 0.1 gram on line (G).

3.10 Place the core in the pan and place in an oven at 230 ± 9° F for 2 hours.

3.11 After the 2 hour period, record the weight of the core and the pan to the nearest 0.1 gram on the first time space on line (J).

3.12 Place the core and pan back in the oven and weigh at 1 hour intervals until the core has reached a constant weight. Constant weight is attained when the weight loss is within 0.1 percent of the apparent dry weight. Calculate the amount of allowable loss (B * .001) to the nearest 0.1 gram. Record on line (M).

3.13 After a constant weight has been attained, cool the pan and core to room temperature. Record the weight to the nearest 0.1 gram on line (N).

3.14 Determine the actual dry weight of the core (N-G). Record on line (H).

3.15 Determine the core bulk specific gravity (H/E) to the nearest 0.001. Record on line (I).

3.16 Determine the moisture in the core (D-H). Record on line (K).

3.17 Calculate the percent water absorbed by volume (K/E * 100) to the nearest 0.1 percent. Record on line (L).

Example for determining coring locations using QC/QA stratified random sampling procedure.

Each 1000 ton sublot is divided into two 500 ton sections of pavement (one core per 500 ton). Using a random number table generate two random numbers to determine the location for each core. The first random number determines the tonnage into the sublot where the core will be taken. The second random number determines the offset distance from the centerline for the core. The station of the random tonnage can be taken from the asphalt checkers weigh tickets. Round the longitudinal distances to the nearest foot (0.3 m) and the offset distances to the nearest 0.5 foot (0.1 m).

The table shows a method using random numbers to determine the core stationing and offset distance from the beginning tonnage of the lot. The tonnage corresponds to the station, which is on the asphalt checkers weigh ticket. Note that the whole lot does not need to be completed prior to determining the coring locations for each individual core.

Core Site	Longitudinal Location random #	tonnage	station	Distance from Centerline	
1A	0 +	500 x 0.57 = 285 ton;	83+86	12 x 0.82 = 9.7';	9.5' Lt.
1B	500 +	500 x 0.90 = 950 ton;	97+21	12 x 0.34 = 4.1';	4' Lt.
2A	1,000 +	500 x 0.47 = 1235 ton;	102+90	12 x 0.68 = 8.2';	8' Lt.
2B	1,500 +	500 x 0.07 = 1535 ton;	108+88	12 x 0.24 = 2.9';	3' Lt.
3A	2,000 +	500 x 0.87 = 2435 ton;	126+94	12 x 0.42 = 5.0';	5' Lt.
3B	2,500 +	500 x 0.90 = 2950 ton;	137+17	12 x 0.88 = 10.4';	10.5 Lt.
4A	3,000 +	500 x 0.88 = 3440 ton;	146+95	12 x 0.97 = 11.5'*;	11' Lt.
4B	3,500 +	500 x 0.19 = 3595 ton;	150+10	12 x 0.70 = 8.3';	8.5' Lt.
5A	4,000 +	500 x 0.34 = 4170 ton;	161+61	12 x 0.36 = 4.2';	4' Lt.
5B	4,500 +	500 x 0.85 = 4925 ton;	176+66	12 x 0.23 = 2.6';	2.5' Lt.

06

* Any transverse distance closer than one (1) foot (0.3 m) from either edge is moved to one (1) foot (0.3 m) from the edge of the top paving width.

The cores are taken by the contractor with the Quality Assurance technician witnessing the coring operation and transporting the cores back to the lab for testing. The cores shall be measured and then separated on the lift line by means of sawing with a diamond blade cut off or masonry saw being careful not to damage the core. The density of each core is determined and the average core density for each 1,000 ton sublot is then determined. The average of the lot's Maximum Specific Gravity (Rice) tests is used to compute the lot average density.

4. Report:

4.1 Calculate the Bulk Specific Gravity to the nearest 0.001.

$$\frac{A}{B - C}$$

A = Mass in grams of the dry core in air.

B = Mass in grams of the saturated surface dry core in air.

C = Mass in grams of the core in water.

4.2 Calculate the core density percent of Standard to the nearest 0.01 by dividing the core bulk specific gravity by the lot's average maximum theoretical specific gravity.

4.3 Calculate the average density percent of standard of the two cores to the nearest 0.1.

4.4 Report the results on a DOT-42Q.

5. References:

DOT-42Q
DOT-8

ASPHALT CONCRETE CORE DRY BACK WORKSHEET

DOT-8
9-01

PROJECT NUMBER: P 0000(00)00
COUNTY: Any
PCN: 1234

TESTED BY: Jim Jones
DATE (S): 7-1-00 and 7-2-00

STEPS

1. Measure and record the thickness of the core and all lifts prior to sawing. (average of 4 locations around core)
2. Saw the lift from the core to be tested and record thickness (A).
3. Using SD 315, record the core apparent dry weight in air (B), the submersed weight under water (C), and the saturated surface dry weight in air (D) to the nearest 0.1 gram.
4. Calculate the volume of the core (E).
5. Record the pan number (F).
6. Weigh and record the weight of a pan to the nearest 0.1 gram (G).
7. Place core and pan in an oven at 230 ± 9 degrees F for 2 hours.
8. After the 2 hour period, record the weight of the core and the pan to the nearest 0.1 gram. Record the weighing time in column (J)
9. Place the core and pan back in the oven and weigh at 1 hour intervals until the core has reached a constant weight. Constant weight is attained when the weight loss is within 0.1 percent of the apparent dry weight. Calculate the amount of allowable loss (M).
10. After the above constant weight has been reached, cool the pan and core to room temperature, record the weight (N), and then determine the actual dry weight of the core (H).
11. Perform calculations (I), (K), and (L).

Core Measurement before sawing CORE NUMBER		5.00	5.50	5.40	5.45	4.50	6.00	6.25	5.40	5.20	4.50
1 of 2 lift measured thickness		2.00	2.10	2.15	2.15	2.10	2.00	2.25	2.00	2.10	2.15
_____ lift measured thickness											
_____ lift measured thickness											
A.	Sawed Core Thickness:	1.95	2.05	2.05	2.10	2.05	1.90	2.20	1.95	2.00	2.10
B.	Apparent dry weight in air:	943.8	948.8	951.2	959.9	957.2	941.8	956.9	945.2	946.3	955.8
C.	Submersed weight in water:	535.3	534.5	538.1	545.3	538.1	530.6	538.7	526.2	535.6	539.6
D.	SSD weight in air:	946.7	951.2	953.6	962.5	958.4	942.9	958.1	947.8	948.1	958.6
E.	Volume of the core: (D - C)	411.4	416.7	415.5	417.2	420.3	412.3	419.4	421.6	412.5	419.0
F.	Pan Number:	1	2	3	4	5	6	7	8	9	10
G.	Weight of pan:	162.4	165.3	162.7	164.5	165.4	167.1	163.6	164.8	165.1	164.2
H.	Actual dry weight: (N - G)	940.7	945.7	949.2	959.1	952.6	937.6	952.1	942.7	943.7	953.5
I.	Core bulk specific gravity: (H / E)	2.287	2.269	2.284	2.299	2.266	2.274	2.270	2.236	2.288	2.276
K.	Moisture in core: (D - H)	6.0	5.5	4.4	3.4	5.8	5.3	6.0	5.1	4.4	5.1
L.	Percent water absorbed by volume: (K / E) * 100	1.5	1.3	1.1	0.8	1.4	1.3	1.4	1.2	1.1	1.2
M.	Maximum allowable weight loss in 1 hour: (B x 0.001)	0.9	0.9	1.0	1.0	1.0	0.9	1.0	0.9	0.9	1.0

CORE DRYING WEIGH BACK AREA

Time (J)											
After reaching constant weight, allow the core & pan to cool to room temp. before weighing for the final time (N)	8:00 AM										
	10:00 AM	1107.7	1114.9	1114.8	1125.8	1121.9	1108.5	1120.9	1110.9	1111.6	1121.8
	11:00 AM	1105.9	1112.9	1112.7	1124.1	1119.5	1106.9	1118.4	1108.6	1109.5	1119.2
	NOON	1103.7	1111.2	1111.9	1123.4	1118.2	1105.2	1116.2	1107.6	1108.7	1118.1
	1:00 PM	1102.9	1110.8			1117.9	1104.5	1115.5	1107.3		1117.5
N. Weight of cooled core and pan		1103.1	1111.0	1111.9	1123.6	1118.0	1104.7	1115.7	1107.5	1108.8	1117.7

Figure 1

DENSITY REPORT - ASPHALT CONCRETE SURFACING DOT - 42Q

4-01

FILE NUMBER _____

COUNTY	Any	PROJECT	P 0000(00)0	PCN	1234
CLASS AND TYPE	Q MVT	LIFT	1 of 2	THICKNESS	2 inches
% ASPHALT BINDER	6.0	ACTUAL FINISHED WIDTH	16.2	STATION	45+51
DATE(S)	7-1&2-00	TESTED BY	Jim Jones	CHECKED BY	ABC
SPECIFICATION REQUIREMENT - PERCENT OF STANDARD REQUIRED			91.0 to 96.0		
LOT NUMBER	1	LOT LOCATION STA.	0+00 Left	TO STA.	249+70
CORE SITE LENGTH	24970'	LOT WIDTH	16'	QUANTITY REPRESENTED	5000 tons

Theoretical Maximum Specific Gravity

Sublot No.	1	2	3	4	5				
Max. Sp. Gr.	2.475	2.477	2.481	2.475	2.482				

Lot Average Maximum Specific Gravity (Standard) 2.478

IN-PLACE DENSITY MEASUREMENT

PERCENT OF STANDARD [(Core Bulk Specific Gravity / Lot Average Maximum Specific Gravity)] x 100

Core Sublot No.	Height	Random Number	Cumulative Tonnage	Station for Core	Random Number	Distance from C/L	Actual Dry Weight in Air	Submersed Weight in Water	SSD Weight	Core Bulk Specific Gravity	Percent of Standard	Average Percent of Standard
1A	1.95	0.35	175	8+75	0.00	*1.0	940.7	535.3	946.7	2.287	92.29	
1B	2.05	0.33	665	33+90	0.53	8.5	945.7	534.5	951.2	2.269	91.57	91.9
2A	2.05	0.80	1400	69+20	0.55	9.0	949.2	538.1	953.6	2.284	92.17	
2B	2.10	0.20	1600	79+39	0.90	14.5	959.1	545.3	962.5	2.299	92.78	92.5
3A	2.05	0.92	2460	122+97	0.27	4.5	952.6	538.1	958.4	2.266	91.44	
3B	1.90	0.53	2765	139+26	0.42	6.5	937.6	530.6	942.9	2.274	91.77	91.6
4A	2.20	0.45	3225	161+85	0.29	4.5	952.1	538.7	958.1	2.270	91.61	
4B	1.95	0.50	3750	190+34	0.15	2.5	942.7	526.2	947.8	2.236	90.23	90.9
5A	2.00	0.01	4005	201+47	0.83	13.5	943.7	535.6	948.1	2.288	92.33	
5B	2.10	0.48	4740	238+41	0.55	9.0	953.5	539.6	958.6	2.276	91.85	92.1

Figure 2

SOUTH DAKOTA ASPHALT CONCRETE MIX DESIGN PROCEDURE

1. **Procedure:**

This procedure follows AASHTO T 245, except as Modified below.

2. **Apparatus:**

2.1 Specimen Extractor – Add the following:

A mechanical extraction device may be used.

2.2 Compaction Hammer – Add the following:

A Humbolt slant foot (1 degree bevel) rotating base hammer is kept in the South Dakota Central Office Mix Design Lab. All other hammers will be compared/calibrated against this hammer. Slant foot rotating base hammers can be used if results can be obtained which are comparable to those obtained in the South Dakota Central Office Mix Design Lab. The South Dakota Mix Design Lab's hammer has been calibrated to a hand-operated hammer.

3. **Test Specimens:**

3.2 Preparation of Aggregates – Add the following:

The following are the minimum number of size fractions to use when recombining the gradation of each individual stockpile. The 3/4" (19.0 mm), 1/2" (12.5 mm), 3/8" (9.5 mm), #4 (4.75 mm), #8 (2.36 mm), and all material passing the #8 (2.36) are the minimum number of sizes required to be used when recombining the stockpiles.

3.3 Determination of Mixing and Compacting Temperatures. Add the following:

3.3.1 Asphalt Cements; mixing temperature shall be 290° ± 10° F. (143° ± 5° C)

3.3.2 Asphalt Cements; compacting temperature shall be 270° ±5° F. (132° ± 3° C)

* Polymer modified Asphalt Cement, (PG number added >90) Mixing temperature and Compaction temperature will be that as recommended by the supplier.

Verify that the mixing and compaction temperature falls within the AASHTO T-245 ranges of 280 ± 30 centistokes for compaction and 170 ± 20 centistokes for mixing by plotting on a temperature viscosity chart.

* Applies only to non modified binders.

3.4 Preparation of mixtures:

Delete 3.4.1, 3.4.2 and 3.4.3 and add the following:

Stockpile samples to be used for a mix design shall be adjusted to approximate the stockpile's average gradation obtained from stockpile tests completed at the time the mix design is to be done. Adjust the laboratory sample gradations to meet the average stockpile gradations down to the #8 (2.36 mm) and recalculate the laboratory - #8 (2.36 mm) gradation to reflect the changes. Weigh into pans material from each sieve size of each material down to the #8 (2.36 mm) (approximately 3750 grams) to make the three (3) Marshall specimens or pan enough material (approximately 1200 grams) to make each Marshall specimen separately. The compacted height shall be 2.5 ± 1/8 inch (64 ± 3 mm). Prepare two (2) pans of material with approximately 1900 grams of aggregate to make the Rice. Heat aggregate samples in an oven overnight or for a minimum of four hours to a temperature not exceeding 50° F (10° C) above the mixing temperature. Following mixing immediately put the mixture in a covered container in an oven maintained at the mixing temperature for a period of two (2) hours. At least five sets of specimens are to be made at 0.5% oil increments. Two Rice (maximum specific gravity) samples are to be made on the next to the last oil increment. The oil content will be based on the total weight of the bituminous mixture.

3.5 Compaction of Specimens:

3.5.1 Delete and substitute the following:

Thoroughly clean the specimen mold assembly and the face of the compaction hammer. Heat the mold assembly to 280° ± 10° F (132° ± 3° C). Heat the hammer face to between 200° to 300° F (90° to 150° C). Place a piece of paper cut to fit inside the mold in the bottom of the mold and then add enough material to make a specimen 2.5 ± 1/8" (63 ± 3 mm), approximately 1250 grams of material into the molds. The correct amount to use can be determined. Spade the mixture vigorously 15 times around the perimeter and 10 times over the interior with a trowel. Slightly round the surface of the mix. The temperature of the mix shall be within the limits established for the compaction temperature. If the temperature is below the minimum required, reheat the mixture in the mold only until it reaches the compaction temperature and then compact the specimen.

3.5.2 Delete and substitute the following:

Unless otherwise specified, apply 50 blows to each specimen with a Marshall slant foot (1 degree bevel) rotating base hammer having a free fall of 18 ± 0.06 inches (457 ± 1.5 mm). Turn the mold over and apply 50 blows to the opposite side of the specimen. Mark the specimen with a crayon or other suitable marking device on the top side of the specimen and allow to cool to near room temperature. Apply pressure to the collar by means of load transfer device to force the specimen out of the mold. A powered extraction device may be used. Allow the specimen to cool to room temperature and then proceed to measure, weigh and test the specimen.

4. Procedure:

4.1 Delete (or placing in an oven for 2 hours). The specimens shall be placed in a water bath.

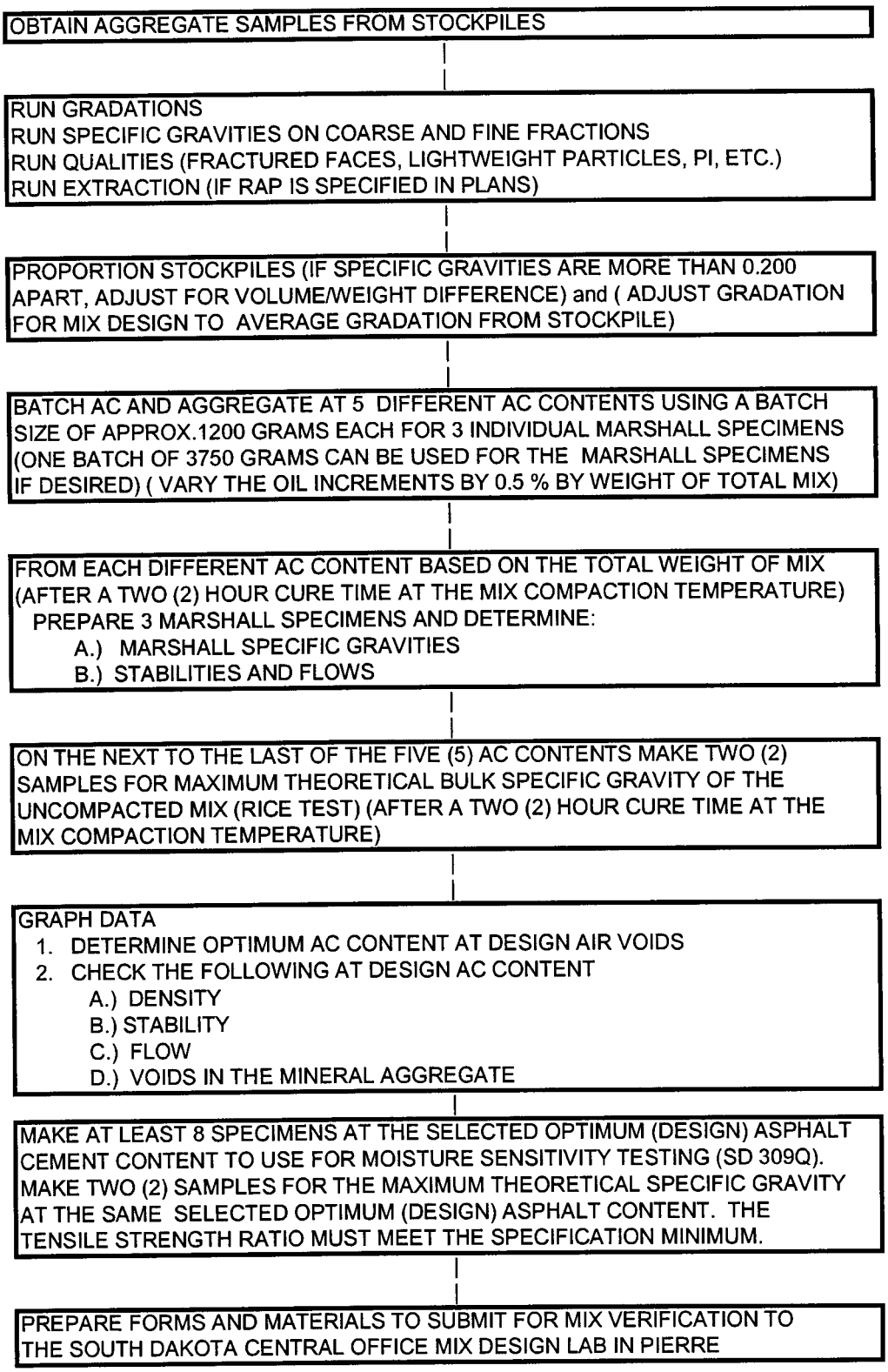
5. Report:

Delete this section and replace with the following:

South Dakota DOT Mix Design data is shown on form DOT 64 which is a Microsoft Excel worksheet. This worksheet generates both the calculations and charts necessary to complete a mix design. The SD DOT Mix Design Lab will verify the mix design submitted by the Contractor and conduct all necessary mix design quality tests required on the mineral aggregate.

Contractor and Consultants can use and submit mix design data and calculations on their own forms and charts as long as all pertinent mix design data is included with the material sent to the SD DOT Mix Design Lab. Aggregate stockpile gradation averages and the +#4 and -#4 bulk specific gravity of each individual stockpile are data which needs to be included with the mix design submittal. A completed DOT 48 form for Moisture Sensitivity shall also be included with the mix design data submitted. SD DOT has a Contractor mix design submittal Excel worksheet which is available from the SD Bituminous Mix Design Engineer in Pierre. The Contractor's material and data submitted to the SD DOT Mix Design Lab in Pierre must meet all of the requirements as shown in the Special Provision Regarding Quality Control/Quality Assurance Specifications.

SOUTH DAKOTA MIX DESIGN PROCEDURE FLOW CHART



Procedure for Evaluating Quality Control Test Results of Aggregate Gradations, Theoretical Maximum Specific Gravity, and Bulk Specific Gravity of Asphalt Concrete Mixes

1. Scope:

To provide a procedure for comparing the Contractor's Quality Control (QC) test results with the Department of Transportation's Quality Assurance (QA) test results for the lot. This procedure is for aggregate gradation and specific gravities of hot mix asphalt concrete and should be used by Area personnel to determine if the QC and QA samples are similar or dissimilar. The similar/dissimilar test should be used to verify that sampling and testing methods are giving comparable test results for the lot tested.

2. Procedure:

2.1 Immediately after the completion of a lot, determine the average of the QC test results for that individual lot. Determine the average percent passing for each sieve size and the average of the theoretical maximum (rice) and bulk (Marshall) specific gravities of the hot mix asphalt concrete.

2.2 Determine the range (R) of the QC samples from the lot by subtracting the smallest test value from the largest value. The range will be calculated for each sieve size, theoretical maximum (rice) and bulk (Marshall) specific gravities.

2.3 Determine the upper and lower interval (I) of the QC test results by using the following equation:

$$I = \text{average} \pm \text{Constant} \times \text{Range}$$

Number of QC samples used in calculating average	Constant
9	0.97
8	1.05
7	1.17
6	1.33
5	1.61

2.4 Compare the Quality Assurance sample tests with the calculated interval (I). A comparison will be made on each sieve size. The comparison will also be made for the theoretical maximum and bulk specific gravities.

2.5 Determine if the results are similar or dissimilar. If all the test results of the QA sample coincide with, or lie between, the upper and lower limits of

their interval, the QC samples will be considered similar to the QA sample. If the QA sample has any sieve size or specific gravity in which a result does not coincide with or lie between the upper and lower limits of their interval, the QC samples will be considered dissimilar to the QA sample.

2.6 If the results are dissimilar, action must be taken to determine the reason for the dissimilar results. Review the QA and QC sampling procedures. Review the QA and QC testing procedures. Check scales and all other testing equipment. Review computations and the reporting procedure. Perform any additional investigation that may clarify the reason for the dissimilarity. The Region Materials Engineer should be involved in the review and investigation. Region Materials IA test results may be used to help identify the reason for the dissimilar test result.

2.7 Perform additional testing if any test result is found to be dissimilar until the reason for the dissimilar test result is found and documented. Document the results of the additional testing and findings in the field diary and the similar/dissimilar worksheet.

3. Report:

Report the results on the similar/dissimilar worksheet. Report the similarity as (yes) similar or (no) dissimilar on the DOT 3Q or DOT 42QA and include the signature of the individual determining if the results are similar or dissimilar. The following computer spread sheet can be used for determining similar/dissimilar results. The spread sheet is available from the SDDOT Bituminous Engineer or from the DOT U drive (U:\ms\Qcqa). The spreadsheet will be available in the MS&T system to record the results. | 06

4. References:

Similar/dissimilar worksheet

COMPARISON OF QUALITY CONTROL AND QUALITY ASSURANCE TESTING

LOT NUMBER _____

PROJECT P0014(126)303 COUNTY Haakon PCN 1234

DATE 6/6/1997 TESTED BY Thomas G. Grannes

	Percent passing the control sieves							Hot mix asphalt specific gravity	
QC test No.	3/4"	1/2"	#4	#8	#16	#40	#200	Max. Theoretical (Rice)	Bulk (Marshall)
11	100	89	70	57	41	22	4.8	2.410	2.333
12	100	91	71	57	42	23	5.5	2.413	2.333
13	100	91	72	58	43	23	5.6	2.409	2.331
14	100	92	72	55	39	21	5.0	2.409	2.339
15	100	91	70	54	39	21	5.5	2.413	2.335
Average	100.0	90.8	71.0	56.2	40.8	22.0	5.3	2.411	2.334
Range (R)	0.0	3.0	2.0	4.0	4.0	2.0	0.8	0.004	0.008
Constant	1.61	1.61	1.61	1.61	1.61	1.61	1.61	1.61	1.61
Interval (I)									
upper	100	96	74	63	47	25	6.6	2.417	2.347
lower	100	86	68	50	34	19	4.0	2.404	2.321
QA test result	100	93	72	59	45	25	5.8	2.405	2.339
Similar/ Dissimilar	similar	similar	similar	similar	similar	similar	similar	similar	similar

Comments: _____

Figure 1

Lime Mill Certification

1. Scope:

Mills furnishing Lime to South Dakota Department of Transportation projects shall be classified by the Chief Materials and Surfacing Engineer as Certified mills or Non-Certified Mills in accordance with this procedure.

2. Apparatus:

2.1 Dipper, hand scoop, sampling tube, shovel or any satisfactory sampling device.

2.2 Sample Cans, 4 lb. (2 kg.)

2.3 Miscellaneous. Brooms, brushes and a funnel.

3. Procedure:

3.1 Certified Mill.

A. Basis for qualification.

(1) A Certified Mill is any mill that furnishes Lime on a relatively continuous basis or a volume sufficient to justify the sampling and testing necessary to qualify and maintain a "Certified" status. The mill shall:

(a) Have an acceptable quality history based upon the manufacturer's data or Department of Transportation test records, as required by the Chief Materials and Surfacing Engineer.

(b) Maintain mill laboratory facilities which are periodically inspected by an authorized representative of the Office of Materials and Surfacing.

(c) As production warrants, and/or as directed by the Chief Materials and Surfacing Engineer, at the beginning of each month, make available a minimum of one random composite sample of material produced during the previous month along with copies of results of tests made

by the plant since the last sample. This sample will be collected from the mill and tested by the Department.

Additional samples may be requested as deemed necessary, to determine the quality of lime being produced.

(d) In addition to making a sample available as specified in (c) above, the certified mill shall also furnish the Central Testing Laboratory weekly certified analysis of its product, reporting the following:

(1) Percent calcium and magnesium oxide.

(2) Percent free water or mechanical moisture.

(3) Accumulative percentage, by weight of residue retained on the #6 (3.35 mm), #20 (0.850 mm) and #100 (0.150 mm) sieves.

(e) When tests confirm non-specification material or product, the certified plant shall be notified of the deviation and may be removed from the certified list until the deviation and cause have been corrected.

3.2 Non-Certified Mills.

A. Basis for qualification.

(1) Any mill not currently identified as a Certified Mill shall be a Non-Certified Mill.

(a) The manufacturer and appropriate Department of Transportation personnel will be notified by the Office of Materials and Surfacing when a mill is certified and when there is a change in a mill's certification.

3.3 Lime Delivery.

A. From a Certified Mill.

(1) Two copies of a Certificate of Compliance shall accompany each conveyance to the project.

(2) No sampling will be required on the project.

B. From a Non-Certified Mill.

(1) Two copies of a properly executed Certificate of Compliance shall be submitted by the manufacturer for each conveyance, prior to or at the time of delivery to the project. Information required by the Certificate may be included as part of the standard bill of lading, loading or weight ticket, or shipping invoice.

The original shall be placed in the project file. The copy shall be forwarded to the Office of Materials and Surfacing.

(2) A sample consisting of two 4-lb. (2 kg) cans shall be obtained and submitted to the Central Testing Laboratory for testing for each conveyance of lime received on the project. The sample shall be obtained from the loading or unloading spout/hose.

Seal sample containers against contamination from air or moisture immediately after filling. Submit the samples and a Certificate of Compliance as required, to the Central Testing Laboratory.

(3) Shipments of Lime received from a Non-Certified mill without the required Certification shall not be used until the Engineer in charge of the project has obtained the documents or has received satisfactory test results on the samples.

3.4 Safety Precautions.

A. Although lime (Calcium Hydroxide) does not normally cause severe burns, care should be exercised to avoid excessive material contact with lungs, eyes and the exposed areas of the body.

4. Report:

Report the test results as set forth in AASHTO M 85.

5. References:

ASSHTO M 85

DOT-60
(09/2001)

SOUTH DAKOTA DEPARTMENT OF TRANSPORTATION
CERTIFICATE OF COMPLIANCE
LIME

FILE # _____

PROJECT_____ COUNTY_____ PCN _____

CAR OR TRUCK NO. _____NET WEIGHT:TON/MTON _____ SEAL NO. _____

MANUFACTURER _____DESTINATION _____DATE _____

This sealed shipment of hydrated lime is in compliance with the Department of Transportation Specifications in effect on the project shown. AND, if submitted herewith, the two test specimens obtained by the manufacturer in accordance with SD 502, are truly representative of the transported material described above. They have been as indicated below.

1. _____ For Truck Shipment — Specimens and certificates sent with driver for delivery to the Project Engineer
2. _____ For Rail Shipment — Specimens mailed directly to: South Dakota Department of Transportation, Central Testing Laboratory, Pierre, SD 57501. The Certificate is mailed to: Project Engineer.
3. _____

Signed _____
Manufacturer's Authorized Agent

==========

INSTRUCTIONS

The Certificate of Compliance and its duplicate copy must accompany each load of hydrated lime, if the material is to be used on the project prior to receipt of satisfactory test results from the Central Testing Laboratory.

Certified shipments of lime which have been sampled by the manufacturer shall have the 2 Certificates (original and one copy) and the 2 test specimens forwarded as follows:

1. SEALED SHIPMENTS BY TRUCK TRANSPORT - The driver shall deliver, to the Engineer in charge of lime blending operations, the 2 Certificates and the 2 test specimens at the time the load is delivered to the project.

2. SEALED SHIPMENTS BY RAILROAD CAR - The original and 1 copy of the Certificate of Compliance shall be affixed to the lower side of 1 of the upper hopper car doors. The inside of the boxcar door, or to the car's placard board. The 2 test specimens (when taken by the manufacturer) should be sent directly to the South Dakota Department of Transportation, Testing Laboratory, Pierre, SD 57501. NOTE: The Project Engineer must be informed by the manufacturer, if the test specimens are sent directly to the Central Testing Laboratory.

CERTIFICATE DISTRIBUTION BY PROJECT ENGINEER:
Original - To project file
Duplicate - To Central Testing Laboratory with test specimens (except in 2., above)

Section Number 5

Section Number 5

Section Number 5

FORMS TABLE OF CONTENT

FORM	FORM DESCRIPTION
DOT 1	Sample Data Sheet
DOT 3	Screen Analysis and P.I. Worksheet
DOT 4	Extraction Reporting Sheet
DOT 5Q	Bituminous Mix Design Calculations
DOT 8	Asphalt Concrete Core Dryback
DOT 16	Summary of Aggregate Test Results and Measurements
DOT 17	Report of Remedial Action
DOT 28	Test Strip Worksheet
DOT 33Q	Lime Content Determination
DOT 42Q	Density Report for Asphalt Concrete Surfacing
DOT 42QA	Air Void Report for Asphalt Concrete Surfacing
DOT 48	Moisture Sensitivity Worksheet
DOT 49	Field Laboratory Inspection Report
DOT 50	Field Laboratory Inspection Record
DOT 53Q	Bulk Specific Gravity of Mineral Aggregate Worksheet
DOT 62	Certificate of Compliance for Asphalt
DOT 64	Report on Aggregate-Bituminous Material Proportions
DOT 65	Job Mix Formula for Asphalt Concrete Surfacing
DOT 66	Spot-Check for Asphalt Binder Content
DOT 67	Distributor "Shot" Record Sheet
DOT 68	Screen Analysis of Mineral Aggregate for Batch Plants Only
DOT 70	Letter of Transfer for Materials
DOT 71	Record of Oral Communication
DOT 74	Project Summary of Asphalt Applied
DOT 76Q	45th Power Chart
DOT 78Q	Temperature / Viscosity Chart
DOT 79Q	Gradation Control Chart
DOT 89	Asphalt Binder Content Determination
DOT 97	Certificate of Compliance for Asphalt Concrete Composite

SAMPLE DATA SHEET

DOT-1
(09/2004)

File No. _____ Laboratory Test No. _____

SUBMITTED BY _____

SEND RESULTS TO _____

CONTRACTOR & SUBCONTRACTOR _____

PROJECT _____ PCN _____ COUNTY _____

CHARGE TO (If not above project) _____

This is a ( ) PRELIMINARY PIT (add. Data on back) ( ) PROCESS CONTROL ( ) ACCEPTANCE

( )INDEPENDENT ASSURANCE ( ) CORRECTIVE ACTION ( ) MIX DESIGN

( ) _____ SAMPLE. ( ) SUBMITTED SPECIFICALLY FOR QUALITY TESTS

FIELD SAMPLE NO. _____ DATE SAMPLED _____, 20___

THIS SAMPLE REPRESENTS _____ (quantity & unit of measurement)

Please identify as: Sta. _____ Dist. L/R _____ Lift _____/ _____ Windrow ( )

FOR CONCRETE Type	Lot No.	FOR SURFACE COURSES	MISCELLANEOUS Type	Lot No.
( ) cement, _____	_____	( ) gravel_____%	( ) beads, _____	_____
( ) admixture, _____	_____	( ) crushed rock _____%	( ) paint, _____	_____
( ) latex modifier, _____	_____	( ) sand _____%	( ) asphalt, _____	
( ) curing compound, _____	_____	( ) clay _____%	Sampling method _____	
( ) coarse agg., size _____	_____	( ) filler _____%	( ) fencing material (list	
( ) fine agg., _____	_____	( ) coated aggregate _____	under remarks)	
( ) cylinders (add. data on back)	_____	( ) lime _____%	( ) _____	

If material is to be used for CONCRETE, check its use as follows: ( ) Class _____

( ) On Grading ( ) On Bridge ( ) Paving ( ) _____

If material is to be used for SURFACE COURSES, check use as follows: ( ) Subbase, Type _____

( ) Base Course, Type _____ ( ) _____ Treated _____ ( ) Gravel Surfacing

( ) Asph. Conc., Class _____, Type _____ ( ) Asph. Surf. Treatment, Type _____ ( ) Shoulders

( ) Maintenance Stockpile ( ) Miscellaneous _____

FOR SHIPPED IN MATERIAL: Producer's Name & Address _____

_____ Brand, Trade Name or Quarry _____

FOR LOCAL MATERIAL: Location of Pit or Quarry _____ 1/4, Sec. _____

Twp.,_____ Range, _____ County _____ Owner & Address _____

==========

Shipping Truck or

Ticket No. _____ Car No. _____ Unloaded At _____

REMARKS:

(over)

SCREEN ANALYSIS AND P.I. WORKSHEET

FILE NUMBER _____

DOT - 3
(09/2004)

COUNTY _____ PROJECT _____ PCN _____

SAMPLE NO. _____ DATE SAMPLED _____ DATE TESTED _____

SAMPLED BY _____ TESTED BY _____ CHECKED BY _____

MATERIAL TYPE _____ SOURCE _____

WEIGHT TICKET NUMBER OR STATION _____ LIFT _____

% moist. = (wet wt. _____ - dry wt.) / dry wt. x 100 = _____

ORIGINAL DRY SAMPLE WT. (0.1g) _____

sieve size mm	sieve size in	F.M. *	Retained (0.1g)	% total ret. (0.1%)	Acc.% pass. (0.1%)	Acc.% pass. (rounded)	SPEC REQ.
50.0	2						
37.5	1 1/2						
31.5	1 1/4						
25.0	1						
19.0	3/4						
16.0	5/8						
12.5	1/2						
9.5	3/8	*					
6.3	1/4						
4.75	#4	*					
PAN							
TOTAL							

wt. before washing(0.1 g) _____
wt. after washing (0.1 g) _____
loss from washing _____
% - #200 _____

+ #4 Gradation Check
within 0.3% of the original dry wt. _____

L. L., P. L., and P. I.

		L.L.	P.L.
a.	can number		
b.	wt. can + wet soil (.01 g)		
c.	wt. can + dry soil (.01 g)		
d.	wt. of water (b - c) (.01 g)		
e.	wt. of can (.01 g)		
f.	wt. of dry soil (c - e) (.01 g)		
g.	Liquid Limit(d/f x j x 100) (0.1)		N.A.
h.	Plastic Limit (d/f x 100) (0.1)	N.A.	
i.	P. I. (g - h) (0.1)		
	Liquid Limit (g. rounded)		N.A.
	Plasticity Index (i. rounded)		

j. corr. # blows _____ 22 = 0.9846, 23 = 0.9899, 24 0.9952
25 = 1.0000, 26 = 1.0050, 27 = 1.0100, 28 = 1.0138

wt. - #40 _____ ÷ wt. - #4 _____ x % pass.#4 _____
(± 3.0% VARIABLE of Acc. % pass. (0.1%) on the #40)

SPECIFICATION L.L. max. _____
SPECIFICATION P.I. max. _____

Design Mix F.M. _____ (Tol. ± 0.2)

sieve size mm	#	Retained (0.1g)	% total ret.(0.1%)	% total x % pa.#4(0.1%)	Acc.% pass. (0.1%)	Acc.% pass. (rounded)	REQ.
2.36	8	*					
2.00	10						
1.18	16	*					
0.850	20						
0.600	30	*					
0.425	40						
0.300	50	*					
0.180	80						
0.150	100	*					
0.075	200						
PAN	dry						
PAN	wash						
TOTAL		*					

wt. before washing(0.1 g) _____
wt. after washing (0.1 g) _____
loss from washing (- #200) _____

+ #4 % PARTICLES LESS THAN 1.95 SP.GR.

Specific gravity of solution (1.95 ± 0.01)		
wt. of lightweight particles	(0.1 g)	
weight of + #4 material	(0.1 g)	
% lightweight particles	(0.1%)	
SPECIFICATION maximum		

- #4 % PARTICLES LESS THAN 1.95 SP.GR.

Specific gravity of solution (1.95 ± 0.01)		
wt. of lightweight particles	(0.1 g)	
weight of - #4 material	(0.1 g)	
% lightweight particles	(0.1%)	
SPECIFICATION maximum		

Coarse _____ x % Retain/Desigr _____
Fines _____ x % Pass/Design _____
Total/Combined - #200 _____

- #4 Gradation check
within 0.3 % of the
wt. before washing _____

CRUSHED PARTICLES TEST

weight of crushed pieces	(0.1 g)	
weight of total + #4 sample	(0.1 g)	
percent of crushed pieces	(%Whole)	
SPECIFICATION _____	or more FF, min.	

Na.Rock _____ Natural Fines _____ Cr.Fines _____
Cr.Rock _____ Natural Sand _____ Ma.Sand _____
Filler _____

COMMENTS: _____

SOUTH DAKOTA DEPARTMENT OF TRANSPORTATION
_____MATERIALS LABORATORY
_____, SOUTH DAKOTA
FILE NO. _____

DOT-4
(09/2004)

Lab Test No. _____

PROJECT NO.: _____ COUNTY: _____ PCN: _____
SUBMITTED BY _____
REPORT TO _____
CONT. PROD. _____
SAMPLE OF _____
TO BE USED _____
SOURCE _____
QUAN. REPRSNTD. _____
DATE SAMPLED _____
DATE RECEIVED _____
DATE REPORTED _____
FIELD TEST NO. _____
COMMENTS _____

Oversize Ret:													
Sieve Sizes													
Inches	mm	Ret.	Ac.p	Ret.	Ac.p	Ret.	Ac.p	Ret.	Ac.p	Ret.	Ac.p	Ret.	Ac.p
3"	75												
2-1/2"	63												
2"	50												
1-1/2"	37.5												
1-1/4"	31.5												
1"	25.0												
3/4"	19.0												
5/8"	16.0												
1/2"	12.5												
3/8"	9.5												
1/4"	6.3												
#4	4.75												
#8	2.36												
#10	2.00												
#16	1.18												
#20	0.850												
#30	0.600												
#40	0.425												
#50	0.300												
#80	0.180												
#100	0.150												
#200	0.075												
Liquid Limit													
Plastic Index													
-4 Lt. Wt. Particle													
+4 Lt. Wt. Particle													
% Crushed PC's.													
F.M.													
Combined -#200													

Deviations/Comparison Results: _____

cc: Area Engineer
Cert. Engineer
Reg. Matl's Engineer

Respectfully submitted: _____

DOT-5Q
(09/2004)

PROJECT NUMBER _____
PCN _____
COUNTY _____
DATE _____
ASPHALT GRADE _____
ASPHALT SP.GR. _____

SAND EQUIVALENT

Sand	Clay	SE
Average SE		

FINE AGGREGATE ANGULARITY

Method A	Method C
Average FAA	

Spec. No.	Ht. (in.)	Dry Wt. (0.1 g)	Sub. Wt. (0.1 g)	SSD Wt. (0.1 g)	Difference (0.1 g)	Bulk Sp. Gr. (0.001 g)	Ave. BSG (0.001 g)	Stability (lbs.)	Corr. Stab. (lbs.)	Flow (0.01 in.)	Av. Flow (0.01 in.)

Theoretical Maximum Specific Gravity of Asphalt Mix (Rice)

	#1	#2	FF 1 or more
(A) Wt. of dry sample			
(B) Wt. of pycn. and water			
(C) Wt. of pycn. + water + sample			
(D) Wt. of SSD sample			
(E) Temperature of water			FF 2 or more
(F) Temperature correction factor			
(G) Maximum theoretical sp.gr.			
(H) Average max.theo.sp.gr.			

Bulk Specific Gravity of the Mineral Aggregate

	+ #4 (Rock) #1	- #4 (Fines) #1	- #4 (Fines) #2
Dry Wt. / Dry Weight			
SSD Wt. / SSD Weight			
Sub. Wt. / Water temp.			
		Flask+water	
		Flask+water + sample	
Bulk Sp. Gr.		Bulk Sp. Gr.	

DOT-8
(09/2004)

CORE DRY BACK WORKSHEET

PROJECT NUMBER: _____ TESTED BY: _____

COUNTY: _____

PCN: _____ DATE (S): _____

Steps

1. Measure and record the thickness of the core and all lifts prior to sawing. (average of 4 locations around core)
2. Saw the lift to be tested from the core and record thickness (A).
3. Using SD 315, record the core apparent dry weight in air (B), the submersed weight under water (C), and the saturated surface dry weight in air (D) to the nearest 0.1 gram.
4. Calculate the volume of the core (E)
5. Record the pan number (F).
6. Weigh and record the weight of the pan to the nearest 0.1 gram (G).
7. Place core and pan in an oven at 230 + or - 9 degrees F for 2 hours.
8. After the 2 hour period, record the weight of the core and the pan to the nearest 0.1 gram. Record the time of weighing in column J.
9. Place the core and pan back in the oven and weigh at 1 hour intervals until the core has reached a constant weight. Constant weight is attained when the weight loss is within 0.1 percent of the apparent dry weight. Calculate the amount of allowable loss (M).
10. After the above constant weight has been reached, cool the pan and core to room temperature, record the weight (N), and then determine the actual dry weight of the core (H).
11. Perform calculations (I), (K), and (L).

Core Measurement before sawing										
CORE NUMBER										
_____ lift measured thickness										
_____ lift measured thickness										
_____ lift measured thickness										

A.	Sawed Core Thickness:										
B.	Apparent dry weight in air:										
C.	Submersed weight in water:										
D.	SSD weight in air:										
E.	Volume of the core: (D - C)										
F.	Pan Number:										
G.	Weight of pan:										
H.	Actual dry weight: (N - G)										
I.	Core bulk specific gravity: (H / E)										
K.	Moisture in core: (D - H)										
L.	Percent water absorbed by volume: (K / E) * 100										
M.	Maximum allowable weight loss in 1 hour: (B x 0.001)										

CORE DRYING WEIGH BACK AREA

	Time (J)										
After reaching constant weight, allow the core & pan to cool to room temp. before weighing for the final time (N)											
N. Weight of cooled core and pan											

SHEET _____ OF _____

DOT-16
(09/2004)

ACCEPTANCE _____
INDEPENDENT ASSURANCE_____

SUMMARY OF AGGREGATE TEST RESULTS
File Number _____

PROJECT _____ COUNTY _____ PCN _____

AREA

MATERIAL TYPE _____ SPECIFICATION REFERENCE _____ ENGINEER _____

TEST IDENTITY								SPECIFICATION											
Sequence	Number	Date 20__	Entry By					SIEVE SIZE									FAILING TEST / Date of DOT-18	STATION TO STATION AND/OR LOCATION	REMARKS

FILE NO. _____

SUMMARY OF MEASUREMENTS

PROJECT _____ COUNTY _____ PCN _____

BASE COURSE GRADING MAT SHOULDER SUBBASE _____ DATE: _____
(Circle designated use) (Other)

TEST IDENTITY		DATE 20	ENTRY BY	LOT NO.	STATION TO STATION	AT STA.	DIST-ANCE FROM ℄	DENSITY (lbs/ft³) (kg/m³)			% OF STANDARD		THICKNESS (in) (mm)		WIDTH (ft) (m)		REMARKS
SEQ.	NO.							AVE.LAB UNIT WT	AVE.FLD UNIT WT	MOVING AVERAGE	REQ'D	OBT'D	SPEC.	FIELD	SPEC.	FIELD	

COPIES TO: Region Materials
Area Engineer

SUBMITTED BY:

_____

DOT-17
(09/2004)

REPORT OF REMEDIAL ACTION

File No. _____

Project No. _____ **PCN** _____

County _____ **Date** _____

TEST NO.	UNACCEPTABLE COMPARISON TEST RESULTS

TEST NO.	REMEDIAL ACTION TEST RESULTS

REMEDIAL ACTION TAKEN: (Attach additional sheets as necessary)

Region Materials Engineer **Date**

cc: Area Engineer
Certification Engineer

DOT-28
(09/2004)

TEST STRIP WORKSHEET

FILE # _____

PROJECT_____ COUNTY_____ PCN _____ DATE _____

TEST NO. _____ TESTED BY _____ CHECKED BY _____

NUCLEAR METER NO. _____ TEST MODE _____ STANDARD COUNT _____

Test Location	1st Reading, Total Passes _____	2nd Reading, Total Passes _____	3rd Reading, Total Passes _____	4th Reading, Total Passes _____	5th Reading, Total Passes _____
STATION	**Wet Dens. , Lbs/ft^3 or kg/m^3**	**Wet Dens., Lbs/ft^3 or kg/m^3**	**Wet Dens., Lbs/ft^3 or kg/m^3**	**Wet Dens., Lbs/ft^3 or kg/m^3**	**Wet Dens., Lbs/ft^3 or kg/m^3**
STATION					
STATION					
STATION					
AVG. Lbs/ft^3 or kg/m^3					

TEST STATION				
Time				
Wt. Of Can & Wet Material				
Wt. Of Can & Dry Material				
Wt. Loss (Moisture)				
Wt. Of Can				
Wt. Of Dry Material				
Percent Moisture				
Dry Density				

AVERAGE DRY DENSITY _____

DOT-33Q
(09/2004)

LIME CONTENT DETERMINATION
ASPHALT CONCRETE

File #_____

REPORT NO. _____

PROJECT_____ COUNTY_____ PCN_____

CONTRACTOR_____ DATE_____

Per Cent Lime Desired_____ Per Cent Used by Test_____

TANK METHOD

A. Weight of Lime in Tank at Start (Tons or MTons)..... _____

B. Weight of Lime Added to Tank (Tons or MTons)..... _____

C. Weight of Lime in Tank at End (Tons or MTons)..... _____

D. Weight of Lime Used (A + B - C) (Tons or MTons)..... _____

E. Weight of Mix Produced (Tons or MTons)..... _____

F. Percent of Lime in Mix (D / E) x 100..... _____

B.

Load #	Invoice #	Tons (MTons)
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

Summary of Mix produced

To Road_____ Tons (MTons)

Plant Waste_____ Tons (MTons)

To Others_____ Tons (MTons)

Produced_____ Tons (MTons)

REMARKS_____

_____

_____

_____

_____

_____

_____

_____

_____

Inspector

DENSITY REPORT - BITUMINOUS SURFACING

FILE NUMBER ___________

PROJECT ______________________ COUNTY ______________________ PCN ________________

CLASS AND TYPE ______________________ LIFT ________________ THICKNESS ________________

% ASPHALT CEMENT ___________ ACTUAL FINISHED WIDTH ___________ STATION ________________

TESTED BY ________________ CHECKED BY ____________________ DATE(S) ________________

SPECIFICATION REQUIREMENT - PERCENT OF STANDARD REQUIRED ______________________________

LOT NO. __________ LOT LOCATION STA. ____________________ TO STA. ________________

CORE SITE LENGTH ___________ LOT WIDTH ___________ QUANTITY REPRESENTED ____________ tons

---

Theoretical Maximum Specific Gravity

Sublot No.									
Max. Sp. Gr.									

Lot Average Maximum Specific Gravity (Standard) _________

IN-PLACE DENSITY MEASUREMENT

PERCENT STANDARD (Core Bulk Specific Gravity / Lot Average Maximum Specific Gravity) x 100

Core Sublot No.	Height	Random Number	Cumulative Tonnage	Station for Core	Random Number	Distance from C/L	Dry Weight in Air	Weight in Water	SSD Weight	Core Bulk Specific Gravity	Percent Standard	Average Percent Standard

DOT-42QA
(09/2004)

AIR VOIDS REPORT - ASPHALT CONCRETE SURFACING

FILE NUMBER _____

PROJECT _____ COUNTY _____ PCN _____
SUBLOT NUMBER _____ DATE _____ TIME _____ LIFT _____
SAMPLE OBTAINED FROM _____ DISTANCE LT. OR RT. OF CENTERLINE _____
TICKET NO. _____ TONS _____ QUANTITY REPRESENTED _____ TONS
TESTED BY _____ CHECKED BY _____
PERCENT BINDER DESIRED _____ DAILY BINDER CONTENT DETERMINATION (DOT-89) _____

THEORETICAL MAXIMUM SPECIFIC GRAVITY (RICE)

(Weighing in Air Method)	1	2	(Weighing in Water Method)
A. Weight of sample in air			A. Weight of sample in air
B. Weight of container + water			B. Weight of Container in water
C. Wt. of container + water + sample			C. Wt. of container + sample in water
Temperature of water ^{0} F			Temperature of water ^{0} F
D. Water correction factor			D. Water correction factor
E. Theo. Maximum Specific Gravity [A / (A + B - C)] x D			E. Theo. Maximum Specific Gravity [A / (A + B - C)] x D
F. Average Theo. Maximum Specific Gravity			F. Average Theo. Maximum Specific Gravity

MARSHALL BULK SPECIFIC GRAVITY DATA

	Specimen number		
A. Height of specimen			
B. Weight of specimen in air			
C. Weight of specimen in water			
D. Weight of SSD specimen in air			
E. Volume Displaced (D-C)			
F. Bulk Specific Gravity (B / E)			
G. Actual Compaction Temperature ^{0} F			
JMF Compaction Temp. _____ ^{0} F			
H. Average Bulk Specific Gravity			

PERCENT AIR VOIDS CALCULATION

[(Maximum Sp. Gr. - Marsh. Bulk Sp. Gr.) / Maximum Sp. Gr.] x 100 = _____

MOISTURE SENSITIVITY REPORT - BITUMINOUS SURFACING

DOT-48
(09/2004)

FILE NUMBER _____

PROJECT		DESIGN LEVEL	
PCN		DESIGN AIR VOIDS	
COUNTY		DESIGN AC CONTENT	
DATE			Spec.'s
ASPHALT BINDER		AVERAGE AIR VOIDS	
ADDITIVE & DOSAGE		AVERAGE SATURATION LEVEL	
METHOD OF ADDING		TENSILE STRENGTH RATION	
COMPACTION BLOWS			

SPECIMEN NUMBER		1	2	3	4	5	6	7	8	9
DIAMETER (.01 in.)	D									
THICKNESS (.01 in.)	t									
DRY MASS IN AIR (0.1 g)	A									
MASS IN WATER (0.1 g)	B									
SSD MASS (0.1 g)	C									
VOLUME (C - B)	E									
BULK SP. GR. (A / E)	F									
THEO. MAX. SP. GR.	G									
% AIR VOIDS ((G-F)/G)x100	H									
VOLUME AIR VOIDS (HE)/100	I									
LOAD (LB.)	P									

AVERAGE AIR VOIDS OF DRY SUBSET

SATURATED _____ MIN. _____ "HG AVERAGE AIR VOIDS OF SAT. SUBSET

MASS IN WATER (0.1 g)	B'									
SSD MASS (0.1 g)	C'									
VOLUME (C' - B')	E'									
VOL. ABS. WATER (C' - A)	J'									
% SATURATION (J'/I) x 100										
% SWELL ((E'-E) / E) x 100										

CONDITIONED 24 HOURS AT 140 DEGREE F WATER

THICKNESS (0.1 in.)	t"									
MASS IN WATER (0.1 g)	B"									
SSD MASS (0.1 g)	C"									
VOLUME (C" - B")	E"									
VOL. ABS. WATER (C" - A)	J"									
% SATURATION (J" / I) x 100										
% SWELL ((E" -E) / E) x 100										
LOAD (LB.)	P"									
DRY STRENGTH ((2P) / tDπ)	Std									
WET STRENGTH ((2P") / t"Dπ)	Stm									
VISUAL MOISTURE DAMAGE										
CRACK / BREAK DAMAGE										

π = 3.1416

TENSILE STRENGTH RATIO $\frac{\text{Average Wet Strength (psi)}}{\text{Average Dry Strength (psi)}} = \frac{\text{Stm1 + Stm2 + … + Stmn}}{\text{Std1 + Std2 + … + Stdn}} = \_\_\_\_ \times 100 =$ _____

EQUIPMENT INSPECTION REPORT
INVENTORY OF CALIBRATED FIELD LAB EQUIPMENT

DOT-49
(09/2004)

PROJECT _____ COUNTY _____ PCN _____

TYPE OF CONSTRUCTION _____ CONTRACTOR _____

AREA ENGINEER _____ PROJECT ENGINEER _____

LAB PERSONNEL _____ LAB TYPE _____

ORGANIZATION RESPONSIBLE FOR EQUIPMENT _____

==========

CALIBRATION RECORDS IN FIELD LABORATORY: YES NO

TEST EQUIPMENT

12" Sieves

63	2 1/2	_____
50	2	_____
37.5	1 1/2	_____
31.5	1 1/4	_____
25.0	1	_____
19.0	3/4	_____
16.0	5/8	_____
12.5	1/2	_____
9.5	3/8	_____
6.3	1/4	_____
4.75	#4	_____
PAN		_____
		_____
		_____
		_____

8" Sieves

9.5	3/8	_____
6.3	1/4	_____
4.75	#4	_____
2.36	8	_____
2.00	10	_____
1.18	16	_____
0.850	20	_____
0.600	30	_____
0.425	40	_____
0.300	50	_____
0.180	80	_____
0.150	100	_____
0.075	200	_____
PAN		_____
		_____
		_____
		_____

Scales

_____
_____
_____
_____
_____
_____

Thermometers & Hydrometers

_____
_____
_____
_____
_____

Measure

_____
_____
_____
_____
_____

Molds

_____
_____
_____
_____
_____
_____
_____

Pycnometers & Viscometers

_____
_____
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Misc. Equip.

_____
_____
_____
_____
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_____
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_____
_____
_____

Meters

Air _____
Volume _____
Density _____
_____
_____
_____

Liquid Limit Devices

_____
_____
_____
_____
_____

Sieve Shakers

_____
_____

Hammers

_____
_____
_____
_____
_____

CALIBRATION & COMPARISONS _____

SAMPLING &/OR TESTING PROCEDURES OBSERVED _____

REMARKS _____

cc: Area Engineer

INSPECTED BY _____
Region Materials Engineer Date

DOT-50
(09/2005)

File No. _____

FIELD LABORATORY INSPECTION RECORD

Project _____ County _____ Contractor _____

This record is provided to determine compliance with specifications, to document acceptable deviations, and to record the initial and final condition of the contract Field Laboratory used on this project.

NOTE: Representatives of the South Dakota Department of Transportation and the Contractor should make the initial inspection and record when the Field Laboratory is placed, ready for use, and the final report when the project is completed or the Laboratory released. Minor deviations which do not impair its usefulness, or are compensated for by related features exceeding minimum specification requirements, will be permitted when explained and documented herein. Changes made in locations of, malfunctions, damages, and/or repairs made to the Field Laboratory shall be recorded. Briefly describe, in column 9, or the summary, all notations made in columns 4, 6, and 8.

ITEM	Quantity or Dimensions	SPECIFICATION COMPLIANCE		CONDITION OF LABORATORY				INSTRUCTIONS: Use numerical values, Col. 2. Indicate by "yes" or "no", Col. 3 & 4. Check ( ) proper column, Col. 5, 6, 7, 8.
				Begin Proj.		End Proj.		
		Satisfactory	Accepted as Noted	Satisfactory	Needs Repair	Satisfactory	Needs Repair	REMARKS
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1. HEATING and/or COOLING SYSTEM								
2. CABINET (enclosed)								
3. CHAIRS/STOOLS								
4. DESK								
5. DIMENSIONS Length _____ Width _____ Height								
6. DOORS								
7. EQUIPMENT (for concrete test specimens, if required)								
8. EXHAUST FANS								
9. LIGHTS (electric)								
10. OUTLETS (electric)								
11. POWER								
12. RANGE/OVEN Size _____ Burners _____								
13. ROOMS OR SECTIONS								
14. SINK								
15. TABLES								

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
16. WATER SYSTEM Capacity _____ Pressure _____ Gravity								
17. WINDOWS								
18. FIRE EXTINGUISHERS								
19. MICROWAVE OVEN								
20. FIRST AID/EYEWASH								
21. BROOM/DUSTPAN/GARBAGE								
22. SANITARY FACILITY								
23. PHONE/ANSWERING MACHINE/FAX/COPIER								
24. CONVECTION OVENS (if applicable)								
25. CONCRETE BASE (if applicable)								
26. STEPS AND HAND RAILINGS								
27. LAB ANCHORING SYSTEM								

SUMMARY AND ADDITIONAL COMMENTS:

_____

_____

_____

_____

_____

_____

_____

_____

_____

DEPARTMENT OF TRANSPORTATION CONTRACTOR

Initial Inspection _____ _____ _____ _____

Name Title Date Name Title Date

Final Inspection _____ _____ _____ _____

Name Title Date Name Title Date

ACCEPTED FOR FINAL PAYMENT _____ _____

Name Date

_____

Title

DOT-53Q
(09/2004)

BULK SPECIFIC GRAVITY OF MINERAL AGGREGATE

PROJECT:
PCN:
COUNTY:

AGGREGATE TYPE:
PIT LOCATION:
% RETAINED #4:
% PASSING #4:

- #4 Bulk Specific Gravity

	#1	#2
(A) weight of oven dry sample in air:		
(B) weight of pycnometer filled with water:		
(C) weight of pycn. + water + sample:		
(S) weight of saturated surface dry sample:		
temperature of the water:		

BULK SP. GR. $\frac{A}{(B + S - C)}$ _____ _____

AVERAGE = [ ]

APPARENT SP. GR. $\frac{A}{(B + A - C)}$ _____ _____

AVERAGE = [ ]

WATER ABSORPTION (percent) (S-A / A) * 100 _____ _____

AVERAGE = [ ]

+ #4 Bulk Specific Gravity

(A) weight of oven dry sample in air: [ ]
(B) weight of sat. surf. dry sample in air: [ ]
(C) weight of saturated sample in water: [ ]
Temperature of the water: [ ]

BULK SP. GR. $\frac{A}{(B - C)}$ _____

[ ]

APPARENT SP. GR. $\frac{A}{(A - C)}$ _____

[ ]

WATER ABSORPTION (percent) $\frac{(B - A) * 100}{A}$ _____

[ ]

SAMPLE BULK SPECIFIC GRAVITY
Gsb = bulk specific gravity for the total sample
P1, P2, Pn = individual percentages by weight of aggregate
G1, G2, Gn = individual bulk specific gravities of aggregate

$$Gsb = \frac{P1 + P2 + \ldots\ldots + Pn}{P1/G1 + P2/G2 + \ldots\ldots + Pn/Gn}$$

Bulk Sp. Gr. (Gsb) = [ ]

SAMPLE APPARENT SPECIFIC GRAVITY
Gsa = apparent specific gravity for the total sample
P1, P2, Pn = individual percentages by weight of aggregate
G1, G2, Gn = individual apparent specific gravities of aggregate

$$Gsa = \frac{P1 + P2 + \ldots\ldots + Pn}{P1/G1 + P2/G2 + \ldots\ldots + Pn/Gn}$$

Apparent Sp. Gr. (Gsa) = [ ]

WATER ABSORPTION (percent)
Aw = water absorption for the total sample
P1, P2, Pn = individual percentages by weight of aggregate
A1, A2, An = absorption percentages for each size fractions

$$Aw = (P1*A1/100) + (P2*A2/100) + \ldots\ldots + (Pn*An/100)$$

Water Absorption (Aw) = [ ]

SOUTH DAKOTA DEPARTMENT OF TRANSPORTATION
CERTIFICATE OF COMPLIANCE FOR ASPHALT
File # _____

*PROJECT_____ COUNTY_____ PCN _____

SUPPLIER _____ CONSIGNEE _____

Bill of Lading or Invoice No. _____ Tank Car or Truck No. _____

**Type & Grade of Material _____ Specific Gravity @ 60^0F. _____ Net Weight _____

DESTINATION _____ DATE SHIPPED _____

TEMPERATURE FOR KINEMATIC VISCOSITY

FOR MIXING APPLICATION	FOR SPRAY APPLICATION
300 Centistokes = _____ ^{0}F	200 Centistokes = _____ ^{0}F.
150 Centistokes = _____ ^{0}F	50 Centistokes = _____ ^{0}F.

This shipment of asphalt material complies with specification requirements of the South Dakota Department of Transportation. The transporting conveyance has been inspected and found free of contaminating material.

SIGNED _____
Supplier's Authorized Representative

* Information may be supplied at destination, if not known when loading.

** If material contains anti-stripping additive, the grade shall be indicated with the notation "with anti-stripping additive".

NOTE: The specimen shown here details the information required.
Such data may be forwarded on the supplier's own invoice, Bill of Lading, or on his own reproductions of the specimen format.

Two (2) copies with each conveyance.

Original - To project file
Duplicate - To Central Testing Laboratory

REPORT ON AGGREGATE-BITUMINOUS MATERIAL PROPORTIONS
SOUTH DAKOTA DOT BITUMINOUS MIX DESIGN LAB
700 EAST BROADWAY AVE., PIERRE, SD

DOT-64
(09/2004)

Project: 0 County: 0 Reported:
PCN 0
Job Location: 0

Date Submitted: ?

Sample Submitted By:

Aggregate Source: ?

Type of Work: 0

Prime Contractor: 0

Subcontractor:

GRADATION OF MINERAL AGGREGATE USED FOR TRAIL MIXTURES
(Accumulative Percentages Passing)

% AGGR =	0	0	0	0	0		Recommended Job Mix
Sieve	?	?	?	?	?	Comp	Gradation
1 IN.	0.0	0.0	0.0	0.0	0.0	0.0	0
3/4 IN.	0.0	0.0	0.0	0.0	0.0	0.0	0
5/8 IN.	0.0	0.0	0.0	0.0	0.0	0.0	0
1/2 IN.	0.0	0.0	0.0	0.0	0.0	0.0	0
3/8 IN.	0.0	0.0	0.0	0.0	0.0	0.0	0
# 4	0.0	0.0	0.0	0.0	0.0	0.0	0
# 8	0.0	0.0	0.0	0.0	0.0	0.0	0
# 16	0.0	0.0	0.0	0.0	0.0	0.0	0
# 40	0.0	0.0	0.0	0.0	0.0	0.0	0
# 200	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Asphalt Binder recommended by weight of total mix = 0.0 per cent PG

The above optimum asphalt percentage is determined by Marshall Mix Design tests on submitted aggregate samples. If variation in aggregate quality or gradation occurs, or if the plant produced mix volumetric properties are different from the lab mix volumetric properties, bitumen requirements may be altered. In case of necessary deviation from the recommended percentages, please notify the Bituminous Office.

50 blow AASHTO T-245 Mix Design criteria are as follows:

Marshall equals ? lbs./cu.ft. at ? % asphalt cement. Air Voids = ? % with ? % VMA. Rice equals ? lbs./cu.ft

Temperature of mixture when emptied from the drum	**285 ± 20° F**
Temperature of mixture on delivery to the road	**275 ± 30 or -20° F**
Asphalt application temperature at the mixer	**290 ± 15° F**
Marshall poundout temperature	**275 ± 10° F**

Copies to:
?
?
?
G. Hedman
File

Sincerely,

James J. CostellO
Bit. Mix Design Engineer

Sincerely

Richard E. Rowen
Bituminous Engineer

File No. _____

DOT-65
(09/2004)

ASPHALT CONCRETE
JOB MIX FORMULA - BITUMINOUS SURFACING

Project _____ County _____ PCN _____

Contractor _____ Asphalt Concrete Type _____

Area Engineer _____ Time _____ Date _____, 20 _____

The following job mix formula with permissible tolerances as set forth in the specifications shall apply to the Bituminous Plant Mix on the above project effective this date until otherwise notified.

1 1/4" sieve	% Passing	_____
1.0" sieve	% Passing	_____
3/4" sieve	% Passing	_____
1/2" sieve	% Passing	_____
3/8" sieve	% Passing	_____
No. 4 sieve	% Passing	_____
No. 8 sieve	% Passing	_____
No. 16 sieve	% Passing	_____
No. 40 sieve	% Passing	_____
No. 80 sieve	% Passing	_____
No. 200 Sieve	% Passing	_____
Asphalt Content) ---- Hot Mix-Main Line	% Total Mix	_____
Asphalt Content) ---- Hot Mix-Shoulders	% Total Mix	_____
Temperature of mixture when emptied from mixer		_____
Temperature of mixture on delivery to the road		_____
Asphalt application temperature (at mixer)		_____

_____
AREA ENGINEER

cc: Bituminous Engineer
Region
Region Materials
Contractor

DOT-66
(11/2005)

ASPHALT PLANT MIX
SPOT CHECK
FILE # _____

PROJECT _____ COUNTY _____ PCN _____

CONTRACTOR _____ INSPECTOR _____ DATE _____

TANK METHOD

A. Specific Gravity of Bitumen @ 60^0 F or 15^0 C ..... _____

B. Weight Per Gallon (L) @ 60^0 F or 15^0 C ..... _____

C. Temperature of Bitumen ..... _____

D. Weight Per Gallon (L) of Bitumen at Temperature ..... _____

E. Gallons (L) in Tank When Check Starts (calibrated stick) ..... _____

F. Weight of Bitumen in Tank (start check) (D x E) ..... _____

G. Weight of Bitumen Added to Tank ..... _____

H. Gallon (L) in Tank When Check Ends (calibrated stick) ..... _____

I. Weight Per Gallon (L) at Temperature ..... _____

J. Weight of Bitumen in Tank (end check) (H x I) ..... _____

K. Weight of Bitumen Used (F + G - J) ..... _____

L. Weight of Mix Produced (lbs. or kg.) ..... _____

M. Percent Bitumen in Mix (K ÷ L) x 100 ..... _____

METER METHOD

N. Applied Temperature of Bitumen ..... _____

O. Weight Per Gallon (L) of Bitumen at Applied Temperature ..... _____

P. Weight of Mix Produced (lbs. or kg.) ..... _____

Q. Stop _____

R. Start _____ O x S ÷ P = _____ x 100 = _____ % of Bitumen in Mix

S. Net Gallons or Liters _____

Calculations & Remarks _____

_____

_____

_____

DOT-66
(11/2005)

DETERMINING POUNDS OF BITUMEN PER GALLON

1. _____ (Spec. Gravity of Bitumen) X _____ (Temp. Factor) = X 8.328 (1) = _____ lbs. (kg) of Bitumen per Gallon (L) @ temperature

2. _____ (Wt/Gal. (L) @ 60^0 F) X _____ (Temp. Factor) = _____ lbs. (kg) of Bitumen Per Gallons (L) @ temperature

Temp. ^{0}C	Temp. ^{0}F	Factor
107	225	0.9436
110	230	0.9419
113	235	0.9402
116	240	0.9385
118	245	0.9369
121	250	0.9352
124	255	0.9336
127	260	0.9319
129	265	0.9302
132	270	0.9286
135	275	0.9269
138	280	0.9253
141	285	0.9236
143	290	0.9220
146	295	0.9204
149	300	0.9187
152	305	0.9171
154	310	0.9154
157	315	0.9138
160	320	0.9122

DISTRIBUTOR "SHOT" RECORD SHEET

DOT-67
(11/2005)

File No. _____

PROJECT _____ COUNTY _____ PCN _____

AREA ENGINEER _____ INSPECTOR _____

MATERIAL _____ SPECIFIC GRAVITY _____ PLAN RATE _____ LBS., GALS OR SQ. YDS.

Sta to Sta	Car or Transp Number	Wt or Gal Start	Wt or Gal Stop	Wt or Gal Used	Oil Temp ^{0}F	Convers. Factor	Comp Gal 60^{0}F	Width	Lin. Ft. Actual	Lin. Ft. Comp	Sq Yds	Actual Lbs, Gals or Sq Yd	Sec	Date	* Code

REMARKS _____

_____

* Weather Code 1. CLEAR 2. PARTLY CLOUDY 3. CLOUDY 4. MIST 5. RAIN 6. SNOW

DOT-68
(09/2001)

SIEVE ANALYSIS

MINERAL AGGREGATE — STATIONARY PLANT MIX

BIN SPLIT DETERMINATION

SAMPLED FROM	TOTAL WT. FROM EACH BIN LBS.	CALCULATED PERCENT
OARSE BIN		
ITER. BIN		
INE BIN		
OTAL		100.0

ECOMMENDED WEIGHT OF EACH SAMPLE, APPROXIMATELY
1 LBS. THESE ARE TO BE REPRESENTATIVE SAMPLES TAKEN
ROM THE COARSE, (AND/OR) INTERMEDIATE AND FINE BINS.
IOTE: SAMPLE WEIGHTS SHALL BE IN COMPLIANCE WITH SD202
ELIEF SIEVES USED:
BLENDED MINUS MATERIAL FOR P.I. TEST
A X B)-C = MINUS 40 FROM COARSE BIN
D X E)-C = MINUS 40 FROM INTER. BIN
F X G)-C = MINUS 40 FROM FINE BIN
(MATERIAL COMBINED AND BLENDED)
IOTE: PROPERLY COMBINED AND BLENDED MINUS 4 MATERAIL
IAY BE USED TO PREPARE MINUS 40 MATERIAL FOR L.L. & P.I.

TEST NUMBER	FILE NUMBER
PROJECT	COUNTY
SAMPLE REPRESENTS TONS, CLASS TYPE	
STATION	TO
TICKET NUMBER	(OR) TO TICKET NUMBER
DATE SAMPLED	SAMPLED BY
TESTED BY	CHECKED BY
AREA ENGINEER	

PLASTICITY INDES (PHYSICALLY BLENDED COMPOSITE SAMPLE)

WT. CAN & WET SOIL			
WT. CAN & DRY SOIL			LIQUID LIMIT
WT. OF WATER			PLASTIC LIMIT
WT. OF CAN			P.I.
WT. OF DRY SOIL			
BLOWS CAN NO.			

PROCEDURE

1. Use the space(s) provided on this form as necessary and applicable to the project and material(s) being tested and reported.
2. Sampling continuous plants: (1) Stop apron feeder, trip by-pass lever and clean chutes. (2) Place sample buckets under each chute and fill at least half full. (3) Stop apron and trip by-pass lever. (4) Weigh buckets to determine bin split. (use to calculate the composite sample). The material in the sample buckets may be split down to run the coarse, (and/or) intermediate, and fine material gradation tests. Smaller samples may be obtained by the above prescribed procedure for this purpose.
3. Sampling batch plants: Bin samples may be obtained from weigh hopper, truck, belt or bins.
4. Gradation and crushed particles test results for each bin are mathematically combined in bin-split proportions to provide the calculated composite gradation and crushed particle percent.
5. Percentages of minus 40 material from each bin, using bin-split porportions, are physically combined and blended to provide the specimen on which the composite liquid limit and plastic index determination is made.

COMPONENT PERCENTAGES AT COLD FEEDS

GRAVEL ________ %
ROCK ________ %
-#4 ________ %
SAND ________ %
FILLER ________ %

OARSE BIN OR COMPOSITE SAMPLE WEIGHT ________ / INTERMEDIATE BIN SAMPLE WT. ________ / FINE BIN SAMPLE WT. ________

SIEVE SIZE	RETAINED (G) (LBS)	% TOTAL RETAINED		CUMULATIVE % PASSING	RETAINED (G) (LBS)	% TOTAL RETAINED		CUMULATIVE % PASSING	RETAINED (G) (LBS)	% TOTAL RETAINED		CUMULATIVE % PASSING	COARSE	CALCULATED INTER.	PERCENTAGES TOTAL	RETAINED TOTAL	% CUMULATIVE % PASSING	SPECIFICATION GRADATUIB	JOB MIX FORMULA
"																			
/4"																			
/8"																			
/2"																			
/8"																			
O. 4																			
AN																			
OTAL SAMPLE		100.0				100.0				100.0									

	TOTAL -#4 SPLIT TO APPROX. 500 GRAMS				TOTAL -#4 SPLIT TO APPROX. 500 GRAMS				TOTAL -#4 SPLIT TO APPROX. 500 GRAMS										
	RETAINED (GRAMS)	PER CENT RETAINED	% RETAINED X %-#4		RETAINED (GRAMS)	% TOTAL RETAINED	% RETAINED X %-#4		RETAINED (GRAMS)	PER CENT RETAINED	% RETAINED X %-#4								
O. 8																			
O. 16																			
O. 40																			
O. 80																			
O. 200																		CRUSHED PARTICLES ____ %	ASPHALT CONTENT ____ %
AN WASH / DRY																			
OTAL		100.0				100.0				100.0									MIX TEMP.

WT. OF DRY SAMPLE BEFORE WASHING ________ AFTER WASHING ________ LOSS BY WASHING ________	WT. OF DRY SAMPLE BEFORE WASHING ________ AFTER WASHING ________ LOSS BY WASHING ________	WT. OF DRY SAMPLE BEFORE WASHING ________ AFTER WASHING ________ LOSS BY WASHING ________	COARSE, INTERMEDIATE & FINE Combined according to bin splig (Recorded to 0.1 percent)	PLANT__ ASPHALT TEMP. ____

LETTER OF TRANSFER FOR MATERIALS

DOT-70
(09/2004)

File # _____

FROM _____ TO _____ DATE _____
Area Area

RE: Material Transfer Form Project (A) _____ PCN _____

To Project (B) _____ PCN _____

As requested by _____, this letter of transfer will provide the data
Contractor

required for permission to transfer the material represented and previously accepted for use.

Material description, producer and remarks _____

_____

_____

_____

Date(s) used on previous Project (A) _____

Identity (Type, size, grade, model, catalogue No., etc.) _____

Batch, Lot No., Tag No., Stamp No. _____

Original Quantity _____

Transfer Quantity _____

Date of Transfer _____

Basis for Acceptance, Project (A): Test No. _____ Date _____

Other _____

For Asphalt Materials Include the following:

*A. Specific Gravity @ 60^0 F. _____

*B. Temperature for Kinematic Viscosities:
300 Centistokes =
150 Centistokes =
200 Centistokes =
50 Centistokes =

C. Transfer Vehicle No. _____

*A copy of the test may be attached to this sheet.

_____ENGINEER

cc: Contractor
Project File
Region Materials
Certification Engineer

DOT-71
(09/2004)

SOUTH DAKOTA
DEPARTMENT OF TRANSPORTATION

FILE NO. _____

RECORD OF ORAL COMMUNICATION

PROJECT _____ COUNTY _____ PCN _____

_____ DATE _____

WITH _____

TEL. _____, VISIT _____, RADIO _____, CONFERENCE _____

PLACE _____

1) PURPOSE _____

2) PERTINENT FACTS _____

3) CONCLUSIONS OR RECOMMENDATIONS _____

cc:

By _____
Title _____

DOT-74
(09/2004)

SOUTH DAKOTA
DEPARTMENT OF TRANSPORTATION

FILE NO. _____

PROJECT SUMMARY OF BITUMEN APPLIED

PROJECT _____ COUNTY _____ PCN _____

SUPPLIER(S) _____ CONTRACTOR _____ AREA ENGINEER _____

Weigh Ticket No.*		NET POUNDS BY GRADE							
Contractor Carrier	Commercial Carrier								Remarks
On Hand	In Storage								Start of Project
Sub-Total – Pounds									
DEDUCTIONS:									
Rejected									
Wasted									
Used off Project									
Left in Storage									
Net Total Pounds									
Net Total Tons									

_____

Inspector Date

DETERMINING POUNDS OF BITUMEN PER GALLON

1. _____ x _____ = _____ x 8.328 = _____ Lbs. Of Bitumen per gallon at temperature
   Sp. Gravity of Bitumen — Temp. Factor

2. _____ x _____ = _____ Lbs. of Bitumen per gallon at temperature
   Wt/Gal. @ 60^0 F. of Bitumen — Temp. Factor

T = Temperature at which bitumen will be pumped

F = Temperature factor

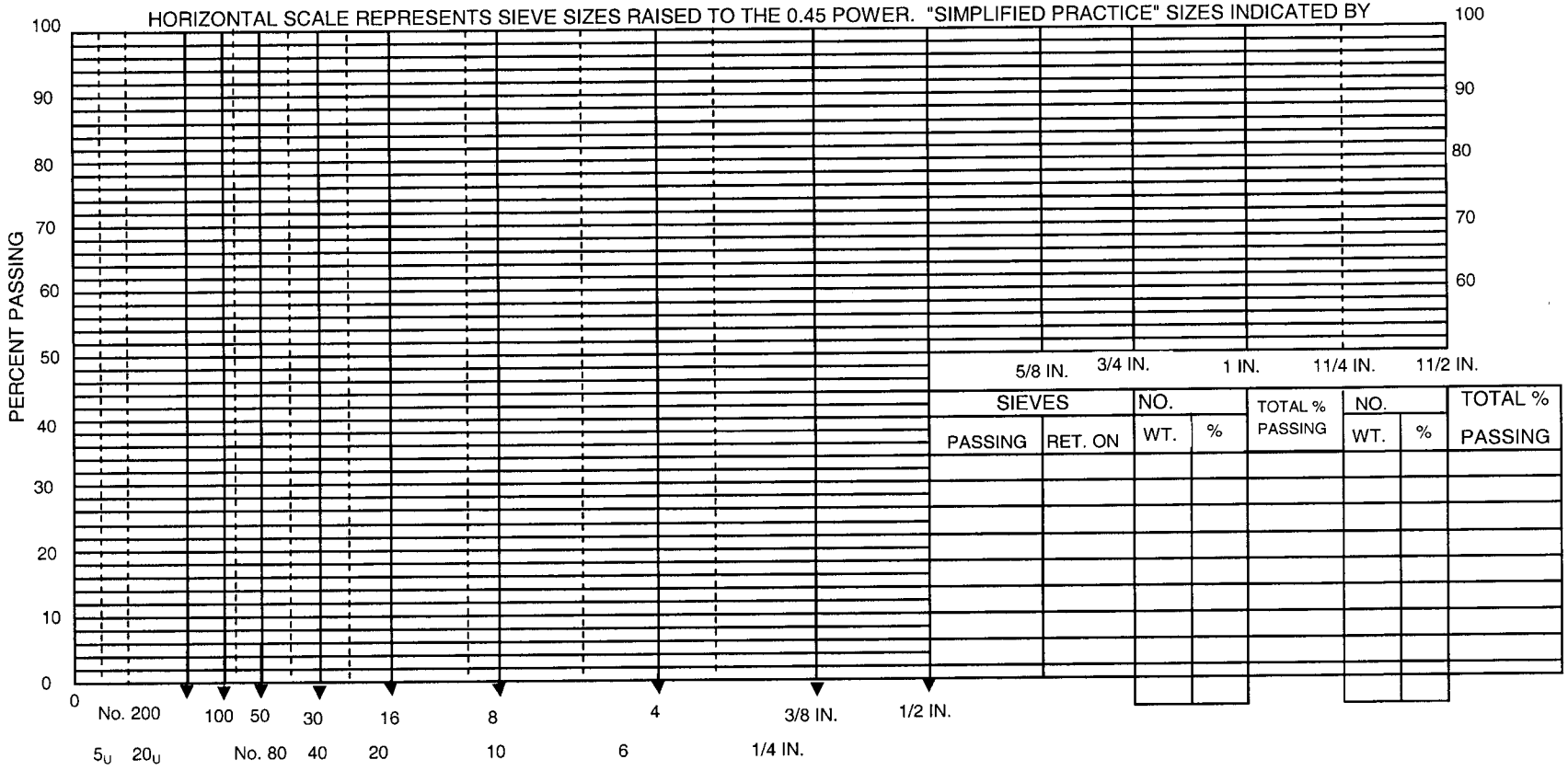
T	F
225	0.9436
230	0.9419
235	0.9402
240	0.9385
245	0.9369
250	0.9352
255	0.9336
260	0.9319
265	0.9302
270	0.9286

T	F
275	0.9269
280	0.9253
285	0.9236
290	0.9220
295	0.9204
300	0.9187
305	0.9171
310	0.9154
315	0.9138
320	0.9122

(09/2001)

GRADATION CHART

HORIZONTAL SCALE REPRESENTS SIEVE SIZES RAISED TO THE 0.45 POWER. "SIMPLIFIED PRACTICE" SIZES INDICATED BY

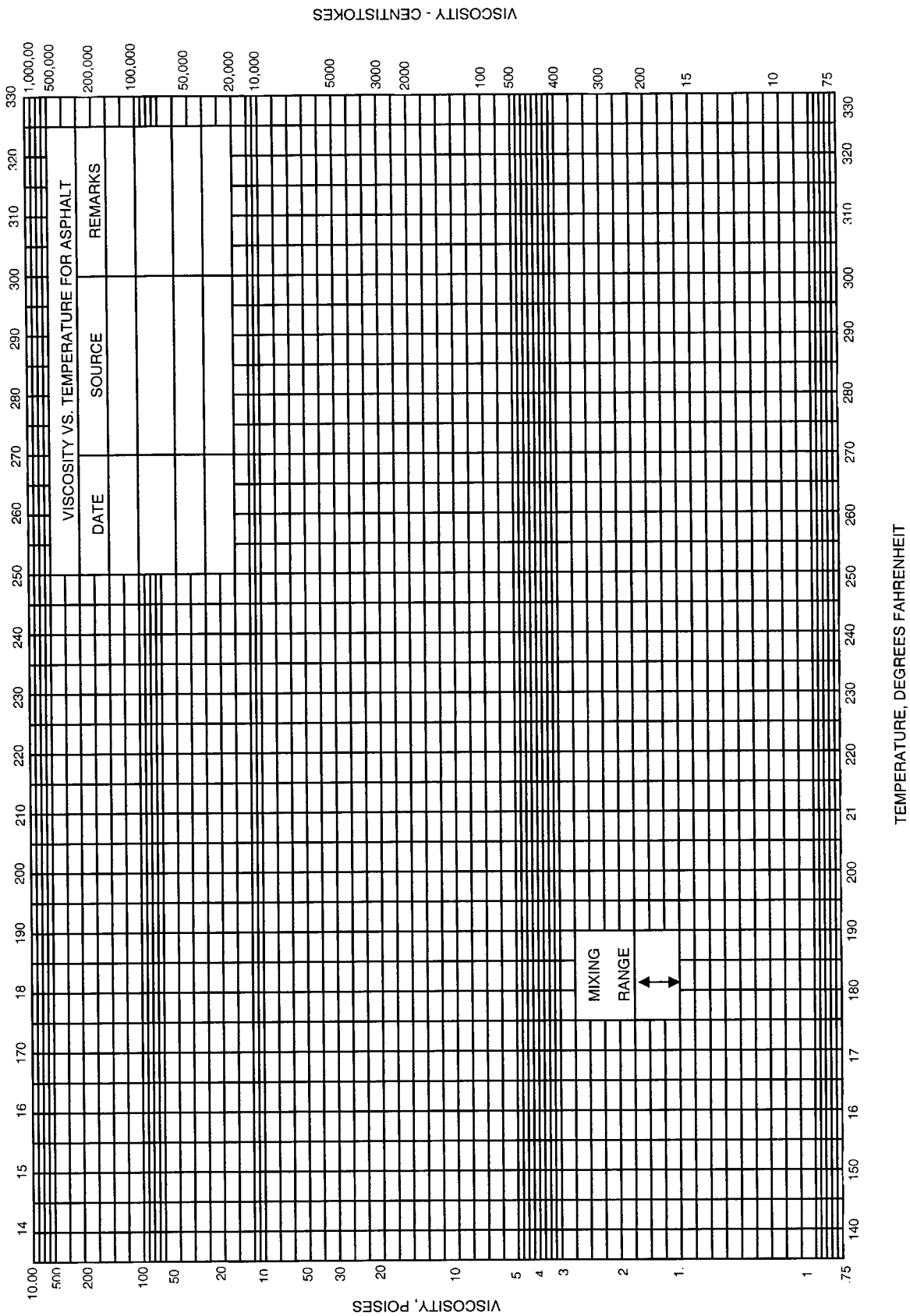


SIEVES		NO.		TOTAL % PASSING	NO.		TOTAL % PASSING
PASSING	RET. ON	WT.	%		WT.	%	

SIEVE SIZES

STATE	PROJECT NO.					TYPE CONST; LOCATION ON PROJECT	
TYPE, SOURCE, PRODUCER OF AGG.							
SAMPLED FROM	SAMPLED BY	DATE	QUANT. REPRESENTED	SIEVED BY	DATE	SIEVE METHOD ☐ WET ☐ DRY	REMARKS

DOT-78Q
(09/2001)

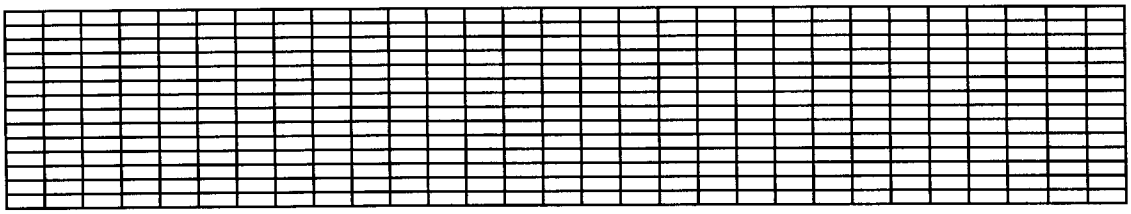


PROJECT:
PCN:
COUNTY

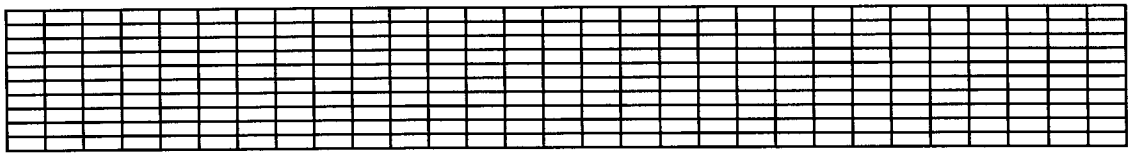
ASPHALT GRADATION
*ADD SHEETS AS NECESSARY

DOT-79Q
(09/2004)

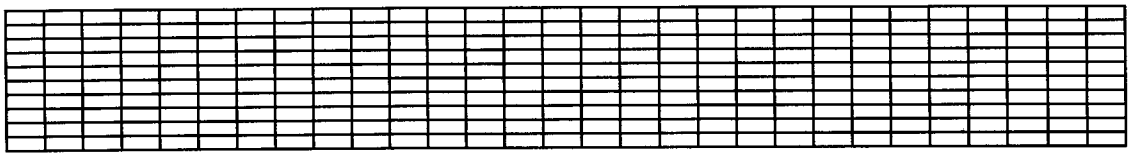
1/2" SIEVE SIZE + -7



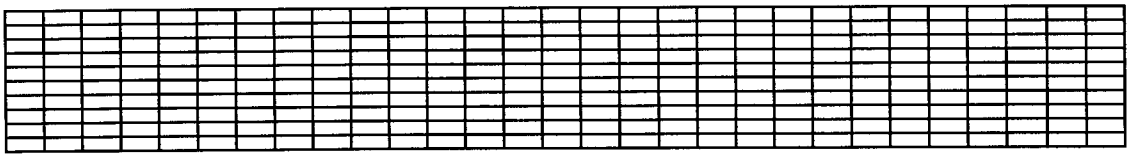
#4 SIEVE SIZE + -5



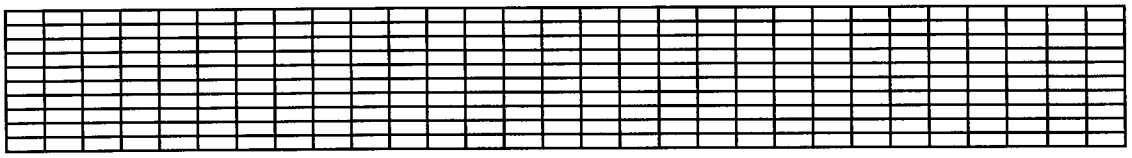
#8 SIEVE SIZE + -5



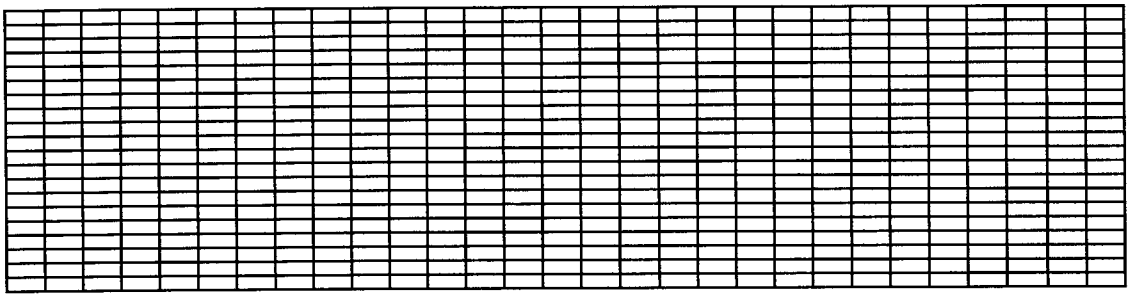
#16 SIEVE SIZE + -5



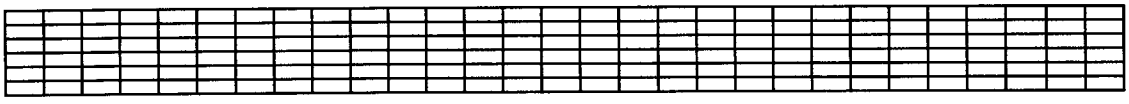
#40 SIEVE SIZE + -5



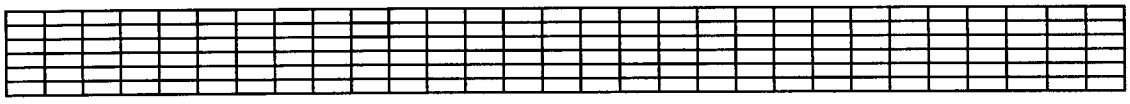
#200 SIEVE SIZE + -2.0



% A.C. + -0.3



DENSITY > 9_ < 96



* PLEASE POST IN PLANT LABORATORY

DOT-89
(09/2004)

SOUTH DAKOTA
DEPARTMENT OF TRANSPORTATION
FILE NO. _____

BITUMEN CONTENT DETERMINATION

PROJECT _____ COUNTY _____ PCN _____ REPORT NO. _____

CONTRACTOR _____ INSPECTOR _____ DATE _____

Percent Bitumen Desired _____ Percent Used by Test _____

TANK METHOD

A. Specific Gravity of Bitumen @ 60°F or 15°C ..... _____

B. Weight Per Gallon (L)@ 60°F or 15°C ..... _____

C. Temperature of Bitumen in Tank when Check Starts ..... _____

D. Weight Per Gallon (L) of Bitumen at Temperature (⋆) ..... _____

E. Gallons (L) in Tank when Check Starts (Calibrated Stick) ..... _____

F. Weight of Bitumen in Tank (start check) (D * E / 2000)(2200) ..... _____

G. Weight of Bitumen Added to Tank ..... _____

H. Temperature of Bitumen in Tank when Check Ends ..... _____

I. Gallons (L) in Tank when Check Ends (calibrated stick) ..... _____

J. Weight Per Gallon (L) at Temperature (⋆) ..... _____

K. Weight of Bitumen in Tank (end check I * J / 2000)(2200) ..... _____

L. Weight of Bitumen Used (F + G – K) ..... _____

M. Weight of Mix produced (Tons or Mtons) ..... _____

N. Percent of Bitumen in Mix (L / M) * 100 ..... _____

(⋆) Compute on reverse side.

G.

Load #	Invoice #	Tons (Mtons)

Summary of Mix Produced

To Road _____ Tons (MTons)
Plant Waste _____ Tons (MTons)
To Others _____ Tons (MTons)
Produced _____ Tons (MTons)

REMARKS: _____

DOT-89
(09/2004)

DETERMINING POUNDS OF BITUMEN PER GALLON

1. _____ X _____ = X 8.328 (1) = _____ lbs. (kg) of Bitumen per Gallon (L) @ temperature
   Spec. Gravity of Bitumen — Temp. Factor

2. _____ X _____ = _____ lbs. (kg) of Bitumen per Gallon (L) @ temperature
   Wt./Gal. (L) @ 60°F — Temp. Factor

Temp. °C	Temp. °F	Factor
107	225	0.9436
110	230	0.9419
113	235	0.9402
116	240	0.9385
118	245	0.9369
121	250	0.9352
124	255	0.9336
127	260	0.9319
129	265	0.9302
132	270	0.9286
135	275	0.9269
138	280	0.9253
141	285	0.9236
143	290	0.9220
146	295	0.9204
149	300	0.9187
152	305	0.9171
154	310	0.9154
157	315	0.9138
160	320	0.9122

DOT-97
(09/2004)

SOUTH DAKOTA
DEPARTMENT OF TRANSPORTATION
FILE NO. _____

CERTIFICATION OF COMPLIANCE FOR ASPHALT CONCRETE COMPOSITE

PROJECT _____ COUNTY _____ PCN _____

CONTRACTOR _____ AREA ENGINEER _____ DATE _____

Asphalt Concrete Class _____ Type _____

Supplier of Asphalt Concrete _____

Supplier of Asphalt Cement _____

Grade of Asphalt Cement _____

Source of Mineral Aggregate _____

JOB MIX FORMULA

¾" Sieve ..... % Passing _____

½" Sieve ..... % Passing _____

#4 Sieve ..... % Passing _____

#8 Sieve ..... % Passing _____

#16 Sieve ..... % Passing _____

#40 Sieve ..... % Passing _____

#200 Sieve ..... % Passing _____

Percent of Asphalt Cement (% By Weight of Total Mix) - - - - - - - _____

Asphalt Application Temperature - _____

Temperature of Mix from Mixer - _____

This Certificate of Compliance certifies that the materials for Asphalt Concrete complies with specification requirements of the South Dakota Department of Transportation.

Signed: _____
Supplier's Authorized Representative

Section Number 6

Section Number 6

Section Number 6

TEST FREQUENCY REDUCTION GUIDELINES

The frequency of the Quality Control testing for Plasticity Index, Lightweight Particles, and Fractured Faces may be reduced by the Area Engineer. The Area Engineer may reduce the frequency beyond what is shown in these guidelines based on an evaluation of test results from the material source. The Area Engineer shall notify the Contractor in writing of the reduction in testing frequency and a copy of this letter forwarded to the Region Materials Engineer. A reduction in testing frequency may be revoked by the Area Engineer at any time.

The frequency of tests performed may be reduced using the following guidelines. The QC technician will complete all tests on the first lot of material produced. A reduction in the frequency of testing will be allowed based upon the average test results obtained from the first lot of material tested by the QC technician. This reduction in test frequency for any of the tests shown below will remain in effect as long as the test results remain within the range of the testing frequency currently being used.

The QA technician will complete all of the required tests on the samples that are selected for QA testing.

PLASTICITY INDEX

NP to 0.5	Reduce test frequency to 1 test per lot
0.6 to 1.5	Reduce test frequency to 2 tests per lot
1.6 to 2.5	Reduce test frequency to 3 tests per lot
2.6 or greater	No reduction in test frequency

+ #4 and - #4 LIGHTWEIGHT PARTICLES (less than 1.95 Specific Gravity)

0 to 0.9 %	Reduce test frequency to 1 test per lot
1.0 to 1.9 %	Reduce test frequency to 2 tests per lot
2.0 to 2.9 %	Reduce test frequency to 3 tests per lot
3.0 % or greater	No reduction in test frequency

FRACTURED FACES

25 % or more above minimum or results of 100 % Fr. Faces	Reduce test frequency to 1 per lot
16 to 24 % above minimum	Reduce test frequency to 2 test per lot
6 to 15 % above minimum	Reduce test frequency to 3 tests per lot
within 5 % of minimum	No reduction in test frequency

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APPENDIX F

COMPARISON OF QUALITY CONTROL AND ACCEPTANCE TESTS

Purpose

The purpose of this procedure is to provide a method of comparing two different data sets of multiple test results - say contractor QC test results and Agency acceptance or verification test results to determine if the material tested came from the same population. The statistical tests used to make the comparisons are called *Hypothesis Tests* and are described in the following paragraphs.

Analysis

To compare two populations that are assumed normally distributed, you may compare their means (averages) and their variabilities (standard deviations or variances). A different test is used for each of these properties. The ***F-test*** provides a method for comparing the variance (standard deviation squared) of two sets of data. Possible differences in means are assessed by a ***t-test***.

The F-test is based on the ratio of the variances of two sets of data. In this case, the F-test is based on the ratio of the variances of the QC test results, S_c^2, and the acceptance test results, S_a^2. The t-test compares sample means, and in this case, is based on the means of the QC test results, $\bar{X}_c$ and the acceptance test results, $\bar{X}_a$.

Hypothesis tests, i.e., the F-test and t-test, are conducted at a selected level of significance, α. The level of significance is the probability of incorrectly deciding the data sets are different when they actually come from the same population. The value of α is typically selected as either 0.05 or 0.01. The following analysis is based on an α of 0.01 so as to minimize the likelihood of incorrectly concluding that the test results are different when they are not.

For the analysis to be meaningful, all of the samples must be obtained in a random manner, the two sets of test results must have been sampled over the same time period, and the same sampling and testing procedures must have been used for both QC and acceptance tests. If it is determined that a significant difference is likely between either the mean or the variance, the source of the difference should be identified. Although it is beyond the scope of the analysis presented here, a computer program could be developed that could identify the existence of significant differences once the test results are input.

If the analysis indicates there is no reason to believe the results came from different populations, then the mean and variance (or standard deviation) could be determined from the combined set of test results to provide a better estimate of the populations parameters

than would be obtained from either of the sets individually.

For information on how the Operating Characteristics curves for these tests can be developed, the reader is referred to statistics text books such as Reference 2.

Procedure

F-test for the Sample Variances

Since the values used in the t-test are dependent upon whether or not the variances are equal for the two sets of data, it is necessary to test the variances of the test results before the means. The intent is to determine whether the difference in the variability of the contractor's QC tests and that of the State's acceptance tests is larger than might be expected from chance if they came from the same population. In this case, it does not matter which variance is larger. After comparing the test results, one of the following will be concluded.

- The two sets of data have different variances because the difference between the two sets of test results is greater than is likely to occur from chance if their variances are actually equal.

- There is no reason to believe the variances are different because the difference is not so great as to be unlikely to have occurred from chance if the variances are actually equal.

First, compute the variance (the standard deviation squared) for the QC tests, S_c^2, and the acceptance tests, S_a^2. Next, compute F, where $F = S_c^2/S_a^2$ or $F = S_a^2/S_c^2$. *Always use the larger of the two variances in the numerator.* Now, choose α, the level of significance for the test. As mentioned previously, the recommended α is 0.01. Next, a critical F value is determined from Table 1 using the degrees of freedom associated with each set of test results. The degrees of freedom for each set of results is the number of test results in the set, less one. If the number of QC tests is n_c and the number of acceptance test is n_a, then the degrees of freedom associated with S_c^2 is $(n_c\text{-}1)$ and the degrees of freedom associated with S_a^2 is $(n_a\text{-}1)$. The values in Table 1 are tabulated to test if there is a difference (either larger or smaller) between two variance estimates. This is known as a two-sided or two-tailed test. Care must be taken when using other tables of the F distribution, since they are usually based on a one-tailed test, i.e., testing specifically whether one variance is larger than another.

Once the value for F_{crit} is determined from Table 1 (be sure that the appropriate degrees of freedom for the numerator and denominator are used when obtaining the value from Table 1), if $F \geq F_{crit}$, then decide that the two sets of tests have significantly different variabilities. If $F < F_{crit}$ then decide that there is no reason to believe that the variabilities are significantly different.

t-test for Sample Means

Once the variances have been tested and been assumed to be either equal or not equal, the means of the test results can be tested to determine whether they differ from one another or can be assumed equal. The desire is to determine whether it is reasonable to assume that the QC tests came from the same population as the acceptance tests. A t-test is used to compare the sample means. Two approaches for the t-test are necessary. If the sample variances are assumed equal, then the t-test is conducted based on the two samples using a *pooled* estimate for the variance and the *pooled* degrees of freedom. This approach is ***Case 1*** described below. If the sample variances are assumed to be different, then the t-test is conducted using the individual sample variances, the individual sample sizes, and the *effective* degrees of freedom (estimated from the sample variances and sample sizes). This approach is ***Case 2*** presented below.

In either of the two cases discussed in the previous paragraph, one of the following decisions is made:

- The two sets of data have different means because the difference in the sample means is greater than is likely to occur from chance if their means are actually equal.
- There is no reason to believe the means are different because the difference in the sample means is not so great as to be unlikely to have occurred from chance if the means are actually equal.

Case 1: Sample Variances Assumed to Be Equal

To conduct the t-test when the sample variances are assumed equal, equation 1 is used to calculate the t value from which the decision is reached.

$$t = \frac{|\bar{X}_c - \bar{X}_a|}{\sqrt{\frac{s_p^2}{n_c} + \frac{s_p^2}{n_a}}} \qquad (1)$$

Where:

$\bar{X}_c$	=	mean of QC tests
$\bar{X}_a$	=	mean of acceptance tests
s_p^2	=	pooled estimate for the variance (described below)
n_c	=	number of QC tests
n_a	=	number of acceptance tests

The pooled variance, which is the weighted average, using the degrees of freedom for each sample as the weighting factor, is computed from the sample variances using equation 2.

$$S_p^2 = \frac{S_c^2(n_c-1)+S_a^2(n_a-1)}{n_c+n_a-2} \qquad (2)$$

Where:
- S_p^2 = pooled estimate for the variance
- n_c = number of QC tests
- n_a = number of acceptance tests
- S_c^2 = variance of the QC tests
- S_a^2 = variance of the acceptance tests

Once the pooled variance is estimated, the value of t is computed using equation 1.

To determine the critical t value against which to compare the computed t value, it is necessary to select the level of significance, α. As discussed above, a value of $\alpha = 0.01$ is recommended. Next, determine the critical t value, t_{crit}, from Table 2 for the pooled degrees of freedom. The pooled degrees of freedom for the case where the sample variances are assumed equal is $(n_c + n_a - 2)$. If $t \geq t_{crit}$, then decide that the two sets of tests have significantly different means. If $t < t_{crit}$ then decide that there is no reason to believe that the means are significantly different.

Case 2: Sample Variances Assumed to Be Not Equal

If the sample variances are not assumed to be equal, then the individual sample variances, rather than the pooled variance, are used to calculate t, and the degrees of freedom used are an estimated effective degrees of freedom rather than the pooled degrees of freedom.To conduct the t-test when the sample variances are assumed not equal, equation 3 is used to calculate the t value from which the decision is reached.

$$t = \frac{|\bar{X}_c - \bar{X}_a|}{\sqrt{\frac{S_c^2}{n_c} + \frac{S_a^2}{n_a}}} \qquad (3)$$

Where:
- $\bar{X}_c$ = mean of QC tests
- $\bar{X}_a$ = mean of acceptance tests

s_c^2 = variance of the QC tests
s_a^2 = variance of the acceptance tests
n_c = number of QC tests
n_a = number of acceptance tests

To determine the critical t value against which to compare the computed t value, it is necessary to select the level of significance, α. As discussed above, a value of $\alpha = 0.01$ is recommended. Next, determine the critical t value, t_{crit}, from Table 2 for the effective degrees of freedom. The effective degrees of freedom, f', for the case where the sample variances are assumed not equal is determined from equation 4.

$$f' = \frac{\left(\frac{s_c^2}{n_c} + \frac{s_a^2}{n_a}\right)^2}{\left(\frac{\left(\frac{s_c^2}{n_c}\right)^2}{n_c+1} + \frac{\left(\frac{s_a^2}{n_a}\right)^2}{n_a+1}\right)} - 2 \qquad (4)$$

Where all the symbols are as described previously.

If $t \geq t_{crit}$, then decide that the two sets of tests have significantly different means. If $t < t_{crit}$ then decide that there is no reason to believe that the means are significantly different.

Example Problem - Case 1.

A contractor has run 21 QC tests for asphalt content and the State highway agency (SHA) has run 8 acceptance tests over the same period of time for the same material property. The results are shown below. Is it likely that the tests came from the same population?

QC Test Results	Acceptance Test Results
6.4	5.4
6.2	5.8
6.0	6.2
6.6	5.4
6.1	5.4
6.0	5.8
6.3	5.7
6.1	5.4
5.9	
5.8	
6.0	

5.7
6.3
6.5
6.4
6.0
6.2
6.5
6.0
5.9
6.3

First, use the F-test to determine whether or not to assume the variances of the QC tests differ from the acceptance tests.

Step 1. Compute the variance, S^2, for each set of tests.

$$S_c^2 = 0.0606 \qquad S_a^2 = 0.0855$$

Step 2. Compute F, using the largest S^2 in the numerator.

$$F=\frac{S_a^2}{S_c^2}=\frac{0.0855}{0.0606}=1.41$$

Step 3. Determine F_{crit} from Table 1 being sure to use the correct degrees of freedom for the numerator (n_a -1=8-1=7) and the denominator (n_c -1=21-1=20). From Table 1, F_{crit} = 4.26.

Conclusion: Since $F < F_{crit}$ (i.e., 1.41 < 4.26), there is no reason to believe that the two sets of tests have different variabilities. That is, they could have come from the same population. Since we can assume that the variances are equal, we can use the pooled variance to calculate the t-test statistic, and the pooled degrees of freedom to determine the critical t value, t_{crit}.

Step 4. Compute the mean, $\bar{X}$, for each set of tests.

$$\bar{X}_c = 6.15 \qquad \bar{X}_a = 5.64$$

Step 5. Compute the pooled variance, S_p^2, using the sample variances from above.

$$S_p^2=\frac{S_c^2(n_c-1)+S_a^2(n_a-1)}{n_c+n_a-2}$$

$$S_p^2=\frac{(0.0606)(20)+(0.0855)(7)}{21+8-2}=0.067$$

Step 6. Compute the t-test statistic, t.

$$t=\frac{|\bar{X}_c-\bar{X}_a|}{\sqrt{\frac{s_p^2}{n_c}+\frac{s_p^2}{n_a}}}$$

$$t=\frac{|6.15-5.64|}{\sqrt{\frac{0.067}{21}+\frac{0.067}{8}}}=\frac{0.51}{\sqrt{0.0116}}=4.735$$

Step 7. Determine the critical t value, t_{crit}, for the pooled degrees of freedom.

degrees of freedom $= (n_c+n_a-2)=(21+8-2)=27.$

From Table 2, for $\alpha=0.01$ and 27 degrees of freedom, $t_{crit} = 2.771$.

Conclusion: Since $4.735 > 2.771$, we assume that the sample means are not equal. It is therefore probable that the two sets of tests did not come from the same population.

Example Problem - Case 2:

A contractor has run 25 QC tests and the SHA has run 10 acceptance tests over the same period of time for the same material property. The results are shown below. Is it likely that the test came from the same population?

QC Test Results	Acceptance Test Results
21.4	34.7
20.2	16.8
24.5	16.2
24.2	27.7
23.1	20.3
22.7	16.8
23.5	20.0
15.5	19.0
17.9	11.3
24.1	22.3
18.6	
15.9	
17.0	
20.0	
24.2	
14.6	
19.7	
16.0	
23.1	
20.8	
14.6	
16.4	
22.0	
18.7	
24.2	

First, use the F-test to determine whether or not to assume the variances of the QC tests differ from the acceptance tests.

Step 1. Compute the variance, S^2, for each set of tests.

$$S_c^2 = 11.50 \qquad S_a^2 = 43.30$$

Step 2. Compute F, using the largest S^2 in the numerator.

$$F = \frac{S_a^2}{S_c^2} = \frac{43.30}{11.50} = 3.76$$

Step 3. Determine F_{crit} from Table 1 being sure to use the correct degrees of freedom for the numerator (n_a-1=10-1=9) and the denominator (n_c-1=25-1=24). From Table 1, F_{crit} = 3.69.

Conclusion: Since $F > F_{crit}$ (i.e., 3.76 > 3.69), there is reason to believe that the two sets of tests have different variabilities. That is, it is likely that they came from populations with different variances. Since we assume that the variances are not equal, we use the individual sample variances to calculate the t-test statistic, and the approximate degrees of freedom to determine the critical t value, t_{crit}.

Step 4. Compute the mean, $\bar{X}$, for each set of tests.

$$\bar{X}_c = 20.1 \qquad \bar{X}_a = 20.5$$

Step 5. Compute the t-test statistic, t.

$$t = \frac{|\bar{X}_c - \bar{X}_a|}{\sqrt{\frac{S_c^2}{n_c} + \frac{S_a^2}{n_a}}}$$

$$t = \frac{|20.5-20.1|}{\sqrt{\frac{11.50}{25} + \frac{43.30}{10}}} = \frac{0.4}{\sqrt{4.79}} = 0.183$$

Step 6. Determine the critical t value, t_{crit}, for the approximate degrees of freedom, f'. Remember that the calculated effective degrees of freedom is rounded down to a whole number.

$$f' = \frac{\left(\frac{s_c^2}{n_c} + \frac{s_a^2}{n_a}\right)^2}{\left(\frac{\left(\frac{s_c^2}{n_c}\right)^2}{n_c+1} + \frac{\left(\frac{s_a^2}{n_a}\right)^2}{n_a+1}\right)} - 2$$

$$f' = \frac{\left(\frac{11.50}{25} + \frac{43.30}{10}\right)^2}{\left(\frac{\left(\frac{11.50}{25}\right)^2}{26} + \frac{\left(\frac{43.30}{10}\right)^2}{11}\right)^2} - 2 = \frac{(4.79)^2}{1.713} - 2 = 11$$

From Table 2, for $\alpha = 0.01$ and 11 degrees of freedom, $t_{crit} = 3.106$.

Conclusion: Since $t < t_{crit}$, (i.e., $0.183 < 3.106$), there is no reason to assume that the sample means are not equal. It is therefore reasonable to assume that the sets of test results came from populations that had the same mean.

Table 1. Critical Values, F_{crit}, for the F-test for a Level of Significance, $\alpha = 0.01$*.

DEGREES OF FREEDOM FOR NUMERATOR

DEGREES OF FREEDOM FOR DENOMINATOR	1	2	3	4	5	6	7	8	9	10	11	12
1	16200	20000	21600	22500	23100	23400	23700	23900	24100	24200	24300	24400
2	198	199	199	199	199	199	199	199	199	199	199	199
3	55.6	49.8	47.5	46.2	45.4	44.8	44.4	44.1	43.9	43.7	43.5	43.4
4	31.3	26.3	24.3	23.2	22.5	22.0	21.6	21.4	21.1	21.0	20.8	20.7
5	22.8	18.3	16.5	15.6	14.9	14.5	14.2	14.0	13.8	13.6	13.5	13.4
6	18.6	14.5	12.9	12.0	11.5	11.1	10.8	10.6	10.4	10.2	10.1	10.0
7	16.2	12.4	10.9	10.0	9.52	9.16	8.89	8.68	8.51	8.38	8.27	8.18
8	14.7	11.0	9.60	8.81	8.30	7.95	7.69	7.50	7.34	7.21	7.10	7.01
9	13.6	10.1	8.72	7.96	7.47	7.13	6.88	6.69	6.54	6.42	6.31	6.23
10	12.8	9.43	8.08	7.34	6.87	6.54	6.30	6.12	5.97	5.85	5.75	5.66
11	12.2	8.91	7.60	6.88	6.42	6.10	5.86	5.68	5.54	5.42	5.32	5.24
12	11.8	8.51	7.23	6.52	6.07	5.76	5.52	5.35	5.20	5.09	4.99	4.91
15	10.8	7.70	6.48	5.80	5.37	5.07	4.85	4.67	4.54	4.42	4.33	4.25
20	9.94	6.99	5.82	5.17	4.76	4.47	4.26	4.09	3.96	3.85	3.76	3.68
24	9.55	6.66	5.52	4.89	4.49	4.20	3.99	3.83	3.69	3.59	3.50	3.42
30	9.18	6.35	5.24	4.62	4.23	3.95	3.74	3.58	3.45	3.34	3.25	3.18
40	8.83	6.07	4.98	4.37	3.99	3.71	3.51	3.35	3.22	3.12	3.03	2.95
60	8.49	5.80	4.73	4.14	3.76	3.49	3.29	3.13	3.01	2.90	2.82	2.74
120	8.18	5.54	4.50	3.92	3.55	3.28	3.09	2.93	2.81	2.71	2.62	2.54
∞	7.88	5.30	4.28	3.72	3.35	3.09	2.90	2.74	2.62	2.52	2.43	2.36

* **NOTE:** This is for a two-tailed test with the null and alternate hypotheses shown below:

$$H_o: S_c^2 = S_a^2$$

$$H_a: S_c^2 \neq S_a^2$$

Table 1. Critical Values, F_{crit}, for the F-test for a Level of Significance, $\alpha = 0.01$*. *(continued)*

DEGREES OF FREEDOM FOR NUMERATOR

DEGREES OF FREEDOM FOR DENOMINATOR

	15	20	24	30	40	50	60	100	120	200	500	∞
1	24600	24800	24900	25000	25100	25200	25300	25300	25400	25400	25400	25500
2	199	199	199	199	199	199	199	199	199	199	199	200
3	43.1	42.8	42.6	42.5	42.3	42.2	42.1	42.0	42.0	41.9	41.9	41.8
4	20.4	20.2	20.0	19.9	19.8	19.7	19.6	19.5	19.5	19.4	19.4	19.3
5	13.1	12.9	12.8	12.7	12.5	12.5	12.4	12.3	12.3	12.2	12.2	12.1
6	9.81	9.59	9.47	9.36	9.24	9.17	9.12	9.03	9.00	8.95	8.91	8.88
7	7.97	7.75	7.65	7.53	7.42	7.35	7.31	7.22	7.19	7.15	7.10	7.08
8	6.81	6.61	6.50	6.40	6.29	6.22	6.18	6.09	6.06	6.02	5.98	5.95
9	6.03	5.83	5.73	5.62	5.52	5.45	5.41	5.32	5.30	5.26	5.21	5.19
10	5.47	5.27	5.17	5.07	4.97	4.90	4.86	4.77	4.75	4.71	4.67	4.64
11	5.05	4.86	4.76	4.65	4.55	4.49	4.45	4.36	4.34	4.29	4.25	4.23
12	4.72	4.53	4.43	4.33	4.23	4.17	4.12	4.04	4.01	3.97	3.93	3.90
15	4.07	3.88	3.79	3.69	3.59	3.52	3.48	3.39	3.37	3.33	3.29	3.26
20	3.50	3.32	3.22	3.12	3.02	2.96	2.92	2.83	2.81	2.76	2.72	2.69
24	3.25	3.06	2.97	2.87	2.77	2.70	2.66	2.57	2.55	2.50	2.46	2.43
30	3.01	2.82	2.73	2.63	2.52	2.46	2.42	2.32	2.30	2.25	2.21	2.18
40	2.78	2.60	2.50	2.40	2.30	2.23	2.18	2.09	2.06	2.01	1.96	1.93
60	2.57	2.39	2.29	2.19	2.08	2.01	1.96	1.86	1.83	1.78	1.73	1.69
120	2.37	2.19	2.09	1.98	1.87	1.80	1.75	1.64	1.61	1.54	1.48	1.43
∞	2.19	2.00	1.90	1.79	1.67	1.59	1.53	1.40	1.36	1.28	1.17	1.00

*** NOTE:** This is for a two-tailed test with null and alternate hypotheses shown below:

$$H_o: S_c^2 = S_a^2$$

$$H_a: S_c^2 \neq S_a^2$$

Table 2. Critical Values, t_{crit}, for the t-test* for Various Levels of Significance.

degrees of freedom	$\alpha = 0.01$	$\alpha = 0.05$	$\alpha = 0.10$
1	63.657	12.706	6.314
2	9.925	4.303	2.920
3	5.841	3.182	2.353
4	4.604	2.776	2.132
5	4.032	2.571	2.015
6	3.707	2.447	1.943
7	3.499	2.365	1.895
8	3.355	2.306	1.860
9	3.250	2.262	1.833
10	3.169	2.228	1.812
11	3.106	2.201	1.796
12	3.055	2.179	1.782
13	3.012	2.160	1.771
14	2.977	2.145	1.761
15	2.947	2.131	1.753
16	2.921	2.120	1.746
17	2.898	2.110	1.740
18	2.878	2.101	1.734
19	2.861	2.093	1.729
20	2.845	2.086	1.725
21	2.831	2.080	1.721
22	2.819	2.074	1.717
23	2.807	2.069	1.714
24	2.797	2.064	1.711
25	2.787	2.060	1.708
26	2.779	2.056	1.706
27	2.771	2.052	1.703
28	2.763	2.048	1.701
29	2.756	2.045	1.699
30	2.750	2.042	1.697
40	2.704	2.021	1.684
60	2.660	2.000	1.671
120	2.617	1.980	1.658
∞	2.576	1.960	1.645

* **NOTE:** This is for a two-tailed test with the null and alternate hypotheses shown below:

$$H_0: \bar{X}_c = \bar{X}_a$$
$$H_a: \bar{X}_c \neq \bar{X}_a$$

Section Number 8

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SDDOT PROFICIENCY SAMPLE PROGRAM

In an effort to improve the Quality Control/Quality Assurance mix design verification process, the SDDOT Bituminous Mix Design Laboratory has started a round robin Proficiency Sample Program and developed a standard mix design submittal spreadsheet for Contractors to use. All Contractors/Consultants submitting mix designs to the SDDOT are required to participate in the Proficiency Sample Program.

SDDOT's new Proficiency Sample Program allows the Bituminous Mix Design lab, Contractors labs, and Consultants labs to compare equipment and technician proficiency under actual testing conditions using samples sent out from the Bituminous Mix Design lab in Pierre. In the fall, samples will be sent to all Contractors and Consultants who have submitted mix designs to the SDDOT. Others wishing to participate in the Proficiency Sample Program can request to be included by contacting Jim Costello at 605 773-3700 or Rick Rowen at 605 773-3427.

South Dakota's round robin Proficiency Sample Program is set up in a manner similar to the AMRL Proficiency Sample Program. SDDOT has been a member the AMRL Proficiency Sample Program for many years. Participants in SDDOT's Proficiency Sample Program will receive a summary showing their results, SDDOT results, and the average results from all participants.

Current South Dakota Test Procedures are in the South Dakota Materials Manual and are at the DOT web site under Materials and Surfacing. These procedures and the requirements in the current edition of the Asphalt Concrete Training Manual (ACTM) should be followed when conducting all of the required tests.

Section Number 9

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QC/QA Project Inspection Report

Mix Type _____ Project Tonnage _____ Lab location _____

Binder Type _____ Testing Firm _____ Lab Site telephone number _____

Quality Control Lab	Comments
Types of mix being produced?	
Types of additional binders being used?	
Are the mix design(s) posted in the lab?	
Are current test procedures&spec prov (8-05)in lab?	
testing equipment calibration records in lab scales , ovens , thermometers , sieves manometer , Marshall hammer	
type and size of lab provided	
Can see plant operations from lab?	
concrete base for Marshall hammer (solid,level)	
type & condition rotating base Marshall hammer	
Thermometers ((type, number, calibrated(labs))	
thermometer of correct type for application	
Rice test conducted above or below water	
calibration curve provided for Rice test(lab water)	
weighing in water apparatus with overflow setup	
correlation testing (mix from Project, Yes or No)	
Fall within tolerances? Gmb, Gmm,Va,gradation	
all testing equipment necessary is provided	
Equipment meets SDDOT test requirements?	
What process used to notify QC to get sample?	
What procedure is used to get samples?	
Is sampling and splitting witnessed by QA?	
test results and original worksheets in lab	
Have any bin split changes been made? DOT3	
Is each bin within 5 % of original mix design?	
Is correct calculations and rounding being used?	
Is the correct numbering system used?	
All test results shown on DOT 3 including moist.	
Signed test results to QA upon test completion	
Any test frequency reductions?	
Was bulk specific gravity reheat done? Results	
Control charts posted (grad., marshall ,rice ,Av)	
Control charts posted (binder %,lime,inpl dens)	
When does QC get QA test results?	
QA and IA test results added to Control Charts	
Are cores sawed with a diamond tipped blade?	
Are backup samples being retained?	
How long are backup samples being retained?	
average air voids (last ___ days)	
Any failing tests on the Project?	
What action was taken?	
Any split samples out of tolerance?	
What corrective action was taken?	
certified II tester name and cert expiration date	
certified II tester name and cert expiration date	
non certified helpers names	
non certified work checked?, has signoff sheet?	
diary contains? Start and stops, changes,spot checks, test results, problems, weather, etc.	
Documentation of any mix design adjustments	
QC comments?	

QC/QA Project Inspection Report

Project Number _____ PCN _____ Date _____

County_____Project Engineer _____ Lab Site telephone number _____

Quality Assurance Lab	Comments
Types of mix being produced?	
Source and types of binders being used?	
Are the mix design(s) posted in the lab?	
Any changes to the original mix design(s)?	
Are the current test proceds. & spec prov in lab?	
type_, size and number of rooms in lab provided	
lab meets requirements? (DOT 50) exceptions?	
Can technicians see plant operations from lab?	
concrete base for Marshall hammer (solid, level)	
type/condition of rotating base Marshall hammer	
Thermometers ((type, number, calibrated(labs))	
thermometer of correct type for application	
Rice test conducted above or below water	
Rice calibration curve with (lab water) for above?	
weighing in water apparatus with overflow setup	
correlation testing (mix from Project, Yes or No)	
Fall within tolerances? Gmb, Gmm,Va,gradation	
all testing equipment necessary is provided	
all equipment meets SDDOT test requirements	
Is correct MS&T numbering & procedures used?	
What process used to notify QC to get sample?	
Is random number procedure used for samples?	
Is random QA sampling being done by QA? Note	
Does QA watch QC sampling and splitting?	
QC and QA test results entered into M S &T	
QA test results given to QC upon completion	
any bin split changes?(amount)shown onDOT 3?	
Was bulk specific gravity reheat done? Results	
Is moisture in the mix test done? Frequency?	
Is core dryback procedure used correctly?DOT 8	
oil content and inpl. density results given to QC?	
IA witness sampling and splitting procedures?	
IA test results available in lab? Added QC charts	
Oil samples & cert entered MS&T? Look at cert.	
PG binder & emulsion samples.Witness or take?	
Receiving daily chart of hot mix temperatures?	
How is daily PG binder cutoff done?Witness or do	
Any out of spec. (0.3) tolerance? Action taken?	
How is daily lime cutoff done? Aggr.1% > SSD?	
Any out of spec.(0.1) tolerance? Action taken?	
average oil content (last ___ days)	
average inplace density (last ___ days)	
Any other failing tests on the Project?	
What action was taken?	
Any QC split samples out of tolerance?	
What corrective action was taken?	
Any IA split samples out of tolerance?	
What corrective action was taken?	
Is similiar/dissimiliar test procedure being used?	
Any dissimilar? Action taken?	
Are all backup samples being retained? For job?	
certified II tester name and cert expiration date	
certified II tester name and cert expiration date	
non certified helpers names	
non certified work checked?, has signoff sheet?	
diary contains?oil%,tons, changes,problems,etc.	
QA comments?	

QC/QA Project Inspection Report

Plant site location_____ Plant # _____ Superint. _____

Contractor_____ Phone No. _____ Plant operators name _____

Plant Site	Comments
enough room at stockpile site?	
are stockpiles separated?	
are stockpiles segregated ?	
are stockpiles contaminated?	
loader operator working entire stockpile?	
bulk heads provided on cold feed bins?	
number of cold feed bins?	
number of different stockpiles used?	
size and type of oversize screen used?	
type of material being rejected by screen?	
type of aggregate sampling device used?	
belt scale type, last checked, Date and by?	
type and brand of plant? Year?	
brand name of automated plant controls?	
Plant maximum production (tph)	
plant running (tons per hour)	
mix temp leaving plant	
oil content setting	
PG oil temp at application in plant	
moisture content in aggregate setting	
plant bin split settings	
scale for mix pay quantity last cert. date and by?	
asphalt meter type, last checked, date and by?	
chart of continuous hot mix temperatures?	
wet wash or baghouse system?	
baghouse fines put back in mix, yes or no?	
burner fuel supplier?	
type of burner fuel and cert? Get copy	
preheated if type >2? To temperature?	
number of asphalt binder storage tanks?	
are they level with chart (1/4") for capacity?	
type of measuring device for storage tanks?	
temperature of binder in storage tanks?	
sample location for PG binder?	
truck loading procedure?	
Are truck boxes clean when returning from road?	
Truck cleaning. What is used to spray boxes?	
scale on lime silo ?	
entire silo on load cells?	
lime scale last checked, date and by?	
4.5 foot min. twin shaft pugmill for lime addition?	
water setup to add at lime addition pugmill?	
aggregate is 1.0 % above SSD condition?	
water spray bar and water system set up?	
water spray bar used at exit end of pugmill?	
how often is moisture content of aggr. checked?	
is fugitive lime dust in air at plant site?	

QC/QA Project Inspection Report

Road site location_____ Road Foreman _____

Plan Typical Sections _____ Number miles to road from plant _____

Road Site	Comments	Additional Remarks
type of surface asphalt being placed on?		
shape of surface being paved on?		
amount of tack ahead of paver		
distributor type and rate of shot		
diluted emulsion ???? Rate shot? Cured?		
vertical faces tacked		
width of pavement being placed		
type and length of bevel, payfactor mix?		
paving toward plant on top lift or approval to differ		
temperature of mix at paver is documented		
temperature of mix in windrow?		
temperature variability in truck load delivered?		
samples taken behind screed or from windrow,Witnessed?		
is pickup machine being used, brand & size ?		
Is the pickup machine picking up all material?		
contractor or state checker, name, title?		
Are the trucks tarped? Length of haul?		
type of release agent being used at paver		
type and model of paver being used		
auto grade and slope controls working?		
material height at auger location		
augers within __ foot of paver edge. extensions?		
type of traveling stringline and length		
type & brand of sensor and number used		
samples taken behind paver screed, witnessed?		
temperature immediately behind paver?		
temperature variability across mat behind paver?		
number of breakdown rollers and type		
frequency of vibratory rollers and speed?		
amplitude of vibratory rollers and speed?		
number of intermediate rollers and type		
compaction rolling completed by 175 F		
number of finish rollers and type		
is bevel being rolled?		
is correct plans typical section being obtained?		
Was test strip used? Discussed at precon meeting?		
roller pattern established and documented?		
roller pattern checked by geo or nuclear gauge?		
consistent paving operation?		
segregation present?		
corrective action taken to correct segregation		
surface texture? Tearing, checking, marks?		
Joints are matching after rolling?		
Joints at centerline on top lift? Offset __ bottom?		
any other irregularities?		
cores taken at random locations next day?		
witnessed by QA?		
core holes filled properly? when?		
ride spec.(notify Jason Smith of compl. date)		
QA Level III certified field inspector's name		
QC Level III certified field inspector's name		
Number of staff on roadway at inspection time		
diary contains? Hours paved, equip.,location, width,crown, tons, weather, mix del.temps, etc.		
Traffic control?		
Flaggers? Multicolored vest? Long shaft paddle?		
Bevels at end of days paving? How long?		
additional comments?		

Section Number 10

Section Number 10

Section Number 10

Section Number 11

Section Number 11

Section Number 11

Section Number 12

Section Number 12

Section Number 12